VOLUNTARY REPORT ON IMPLEMENTATION OF THE PROGRAMME OF WORK ON MARINE AND COASTAL BIOLOGICAL DIVERSITY

HELCOM

Helsinki Commission

Baltic Marine Environment Protection Commission

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VOLUNTARY REPORT ON IMPLEMENTATION OF THE PROGRAMME OF WORK ON MARINE AND COASTAL BIOLOGICAL DIVERSITY IN THE BALTIC SEA REGION

1. Introduction

HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area and works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. This report presents a regional overview of status and trends of marine and coastal biodiversity in the Baltic Sea and evaluates the implementation of the CBD Programme of work on marine and coastal biological diversity in the Baltic Sea region.

2. Meeting the objectives of the Convention

The Baltic Sea is a heavily used, shallow and enclosed sea area, which has faced severe declines in fish stocks and mammal populations due to historical and current fishing and hunting pressures as well as environmental toxification. High nutrient loading from the drainage area has caused eutrophication of the marine environment which has resulted primarily in increased growth of planktonic algae, declines of submerged aquatic vegetation due to decreased light availability and death of deep-water benthic invertebrate communities due to hypoxia and anoxia. Annual blooms of cyanobacteria have increased in frequency and magnitude during the last decades.

The over 30 years of regional co-operation in the protection of the Baltic Sea marine environment has slowed down the loss of biodiversity, resulted in success stories and led to stronger commitments by the Contracting States to save the marine environment. The HELCOM Baltic Sea Action Plan (BSAP) which was adopted at a HELCOM ministerial meeting in 2007[1] (see Appendix 1) includes four main segments – eutrophication, biodiversity, hazardous substances and maritime traffic – has the overarching aim of implementing the ecosystem approach in order to reach a good ecological status in the area by 2021. The BSAP is seen as a strategic document which contributes to the regional level implementation of various international agreements. The biodiversity segment of the BSAP directly facilitates implementation of the CBD Programme of work on marine and coastal biological diversity in the Baltic Sea region.

3. Theme 1: Integrated Marine and Coastal Area Management

Policy instruments and strategies

HELCOM is a regional forum for monitoring, assessing and agreeing on measures and policies realated to the protection of the Baltic Sea marine environment. HELCOM work is divided to groups responsible for addressing maritime activities (HELCOM MARITIME), monitoring and assessment (HELCOM MONAS), biodiversity and nature

[1] http://www.helcom.fi/BSAP/en_GB/intro/

conservation (HELCOM HABITAT), pollution risk and accident response (HELCOM RESPONSE), and land-based pollution (HELCOM LAND). Each group has also *ad hoc* expert groups and projects working on more specific issues. HELCOM has over 200 specific Recommendations[2] and has adopted several Ministerial Declarations[3] wich support the aims to reach the ecological objectives set for the region. HELCOM periodically produces thematic assessments to evaluate the impacts of existing measures and the first thematic assessment on the biodiversity of the Baltic Sea is currently at a final draft stage (Appendix 2).

HELCOM co-ordinates Baltic wide, harmonised data compilation and supports public internet-based interfaces to deliver environmental data to end users. The HELCOM GIS[4] includes web-based interactive map services which provide information on marine protected areas, maritime traffic, accidents and oil spills, accident response facilities, nutrient loading, monitoring stations, coastal fish abundance, and hydrography (including a water forecast service). HELCOM also facilitates databases on Baltic Sea Protected Areas,[5] Baltic Sea Alien species,[6] and a Baltic Sea bibliography[7]. HELCOM fact sheets[8] provide information on threatened and declining species and habitats and annually updated HELCOM Indicator fact sheets[9] contain information and data on tens of indicators related to hazardous substances, nutrients, shipping and biodiversity etc. Moreover, the HELCOM web pages host all the Recommendations, declarations, assessments, and general information on the Baltic Sea.

Indicators

HELCOM work is much based on indicators, which are accepted by HELCOM MONAS. The data is collected by national institutes and agencies and compiled in a co-ordinated way by responsible institutes/agencies into HELCOM indicator fact sheets.

At present, the indicator fact sheets include information about:

- hydrographic variations (temperature, salinity, inflows and runoff) which largely regulate marine life,
- inputs and concentrations of nutrients and hazardous substances,
- plankton blooms and species composition,
- temporal trends in coastal fish communities,
- radioactivity,
- illegal oil discharges,
- predatory bird health, and
- health of seals.

The HELCOM assessments are shifting towards indicators which show the conservation status of habitats and species. First assessments including classification of current status, using specified reference conditions and target values, have been done for eutrophication status and biodiversity of the sea area [10] [11].

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2 http://www.helcom.fi/Recommendations/en_GB/front/
3 http://www.helcom.fi/ministerial_declarations/en_GB/declarations/
4 http://www.helcom.fi/gis/en_GB/HelcomGIS/
5 http://bspa.helcom.fi/
6 http://www.corpi.ku.lt/nemo/alien_species_search.html
7 http://www.baltic.vtt.fi/
8 http://www.helcom.fi/environment2/biodiv/endangered/en_GB/fact_sheets/
9 http://www.helcom.fi/environment2/ifs/en_GB/cover/
10 Meeting documents of HELCOM MONAS 8/2008: www.helcom.fi → meeting portal → MONAS

Direct Action in the Sea Area

The HELCOM Baltic Sea Action Plan includes several biodiversity-related direct actions. Some of the actions, most relevant to the Programme of work, have been listed below:

- The HELCOM Contracting States committed themselves to further voluntary activities in ports and shipping companies to dispose of sewage to the port reception facilities under the existing HELCOM "no-special-fee" system[12]. The countries also agreed on a joint submission to IMO in 2009 to apply for special area status under Annex IV to MARPOL 73/78 to eliminate waste water discharges particularly from passenger and ferry ships.
- In the Helsinki Convention, HELCOM Contracting States have regulated dumping of dredged spoils and hazardous substances to the sea and have recently adopted more specific guidelines[13]. Also sand and gravel extraction activities require permission from national authorities and in larger cases also an environmental impact assessment[14].
- The eutrophication segment of the BSAP includes provisional country-wise nutrient reduction targets for loads of phosphorus and nitrogen to the sea[15]. To reach these reduction targets, measures for enhanced waste water treatment in municipalities[16] and single-family homes[17] were adopted. Moreover, also measures towards phosphate-free detergents[18] were agreed upon.
- Although fisheries is not directly under HELCOM's mandate (with the European Community having exclusive competence in this field for open sea fisheries), HELCOM is involved in discussions on Baltic fisheries management and impacts of fisheries on Baltic biodiversity[19]. In the BSAP, countries have agreed through their competent authorities to work to reduce bycatch of non-target species, to eliminate illegal, unregulated and unreported fisheries, implement long-term management plans for commercially exploited fish species and to make an inventory and classification of rivers with historic and existing migratory fish species (e.g. salmon and sea trout.).Moreover, an international co-ordination group has been already established to monitor, assess, create management guidelines and long-term management plans for coastal fish communities.
- Currently the Contracting Parties are discussing about possible fisheries management measures in the management plans of marine protected areas in order to protect biodiversity of the protected areas.

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[11] Meeting documents of HELCOM BIO 6/2008: www.helcom.fi → meeting portal → HABITAT → BIO
[12] BSAP, Maritime Segment, p. 28.
[13] http://www.helcom.fi/stc/files/Guidelines/GuidelinesDredgedMaterial.pdf and The Helsinki Convention (1992), Annex V
[14] http://www.helcom.fi/Recommendations/en_GB/rec19_1/
[15] BSAP, Eutrophication Segment, p. 10.
[16] http://www.helcom.fi/Recommendations/en_GB/rec28E_5/
[17] http://www.helcom.fi/Recommendations/en_GB/rec28E_6/
[18] http://www.helcom.fi/Recommendations/en_GB/rec28E_7/
[19] BSAP, biodiversity Segment, p. 21.

4. Theme 2: Living Resources

Key components of and major threats to the ecosystem

The main threats to the Baltic Sea ecosystem are eutrophication, heavy fishing pressure, hazardous substances and maritime traffic (including introduction of alien species, illegal oil spills and the risk for a major oil accident). A general overview of the key threats is given in HELCOM BSAP and the more comprehensive biodiversity assessment is in Appendix 2 of this report.

The Baltic Sea is one of the most well-studied ecosystems in the world. It is a brackish-water environment with a steep salinity gradient between the very saline Danish straits in the southwest and the almost freshwater environment in the north and eastern most basins. This salinity gradient and the harsh winters, make the Baltic Sea a stressful living environment, thus supporting a low number of uniquely adapted species, of both marine and freshwater origin. The low species richness results in low resilience to external pressures and the majority of Baltic biodiversity is dependent on very few keystone species of marine origin, so-called habitat-forming species.

Bladderwrack *Fucus vesiculosus* is a large brown alga forming a distinct zone on hard substrata at 0.5-8 meters' depth in the whole sea area. Tens of invertebrate and fish species use the alga as a host, either permanently or at some stage of their life cycle, and even more species are dependent on the habitat as feeding grounds. Eutrophication has led to decline of bladderwrack due to increased sedimentation and complex competitive interactions with other algae. Recent improvements in the status of coastal waters have led to increased biomass of the species, but in offshore areas, where water quality has further detoriorated, the growing depth of bladderwrack has been reduced.

Eelgrass *Zostera marina* grows on sandy bottoms from the southern to northern Baltic Sea, excluding the Gulf of Bothnia and the eastern Gulf of Finland due to low salinity. Eelgrass stabilizes soft bottoms improving living conditions for many invertebrate species and is an important spawning, nursery and feeding ground for fish and birds. Eelgrass is sensitive to decreased light availability and the shadowing effect of epiphytic algae.

Musselbeds of the species *Mytilus edulis* and *M*. *trossulus* are an important habitat for several invertebrate species, therefore supporting also a rich fish and avian fauna. In contrast to the previously described species, blue mussels benefit from eutrophic conditions and are currently thriving in the Baltic Sea. However, increased drifting algal mats cause sufocation and deterioration of this habitat.

In many areas of the Baltic Sea also the red alga *Furcellaria lumbricalis* has been considered a very important habitat-forming species, supporting rich fauna. Since this species is not obligatorily dependent on hard substrum but may drift freely, it is not as sensitive to eutrophication of the sea.

Trends in predatory species

Since the early 20th century the populations of many predatory bird, fish and mammal species had declined severely in the Baltic Sea due to heavy hunting, persecution, fishing and impacts on health caused by high toxin levels. During the last two decades some positive trends have emerged – one success story being the recovery from near extinction of the white-tailed eagle, an important top-predator in the Baltic, which is currently breeding and expanding its range in all the Baltic Sea coastal countries.

The great cormorant *Phalacrocorax carbo sinensis* was exterminated as a breeder in several Baltic Sea countries during the 19th century. Because of protection measures, including banning of hunting, an exponential population growth started in the late 20th century leading to the current population size of ca 75,000 breeding pairs in the Baltic Sea area. As a predator of small-sized fish the great cormorant has greatly benefited from the high abundance of small coastal fish in eutrophicated sea areas.

There are three species of seals in the Baltic Sea: grey seal *Halichoerus grypus*, harbour seal *Phoca vitulina* and ringed seal *Phoca hispida botnica*. After severe hunting pressure in early and mid 20th century and more recent reproductive disorders caused by toxic contiminants, all the species were rare and some populations near extinction. Due to protective measures and decreased concentrations of toxins, populations of all the three species are currently growing. Ringed seal has, however, still quite low population growth due to toxin-affected reproductive failures and two of its four sub-populations are very threatened. Baltic seal species have an important role as top-predators in the ecosystem.

Harbour porpoise *Phocoena phocoena* has two distinct populations in the Baltic Sea area: one in Kattegat, which is a part of the North Sea population, and one in eastern Baltic waters. Both populations are threatened and declining due to, among other things, bycatch in fisheries. A new EU ban on drift nets in the sea area and the HELCOM BSAP commitment to reduce the bycatch of harbour porpoises may have a positive effect on the Baltic populations. The harbour porpoise is the only native cetacean species in the Baltic Sea area.

Cod *Gadus morhua* is a large predatory fish in the Baltic Sea and the most important commercial fish species in the region. The eastern cod population has been unsustainably fished for several years which has led to a very small stock size, decrease in size of individuals and, according to some studies, an ecosystem regime shift to a sprat dominated pelagic community. This may partly explain some observed changes in the food web and species compositions at lower trophic levels. The EU long-term management plan for Baltic cod, which came into force in January 2008, regulates more clearly the fishing effort, quotas, reporting and enforcement of the cod fishery.

Salmon *Salmo salar* and sea trout *S. trutta* are anadromous species spending most of their adulthood in the sea. Populations of both species have suffered from damming of spawning rivers and fishing pressure in sea. The recent EU drift net ban and HELCOM BSAP commitments to protect and restore important salmon/sea trout rivers may increase the stocks of the species.

The HELCOM Baltic Sea Action Plan implements an ecosystem aproach to the management of human activities. There have not been comprehensive studies in the Baltic on the effects of fisheries on the biodiversity. Focused fisheries management measures will surely have positive effects on biodiversity[20]. In the HELCOM BSAP, the HELCOM Contracting Parties have agreed to strive for, by 2012, that bycatch of

[20] http://www.habitatmarenatura2000.de/en/downloads/berichte/MPA_Fisheries_Workshop_2004.pdf

undersized fish and non-target species be minimized, that new adequate techniques and measures are evaluated and implemented to reduce bycatch, and that all caught species and bycatch which cannot be released alive must be landed and reported.

Economical value of the Baltic Sea ecosystem goods and services have not been comprehensively evaluated. Such research projects have however been initiated in the region.

The whole Baltic Sea area falls under national jurisdiction of the riparian countries as there are no areas that could be considered as being located beyond Exclusive Economic Zone (EEZ). Protection of marine living resources in marine EEZ is therefore under the national jurisdiction of the HELCOM Contracting States.

5. Theme 3: Marine and Coastal Protected Areas

Article 15 of the 1992 Helsinki Convention commits HELCOM Contracting Parties to conserve natural habitats and biological diversity and to protect ecological processes. In 1994, HELCOM launched an international network of marine protected areas (MPAs) covering the whole Baltic Sea area[21]. At present the network of *Baltic Sea Protected Areas* (BSPAs) covers 6 % of the marine area and ca. 7 % if terrestrial areas are included (Figure 1). Together with the EU Natura 2000 and Ramsar networks the MPA network covers over 10% of the sea area. A HELCOM BSPA database[22] presenting site-specific information of the BSPAs is accessible via the HELCOM website.

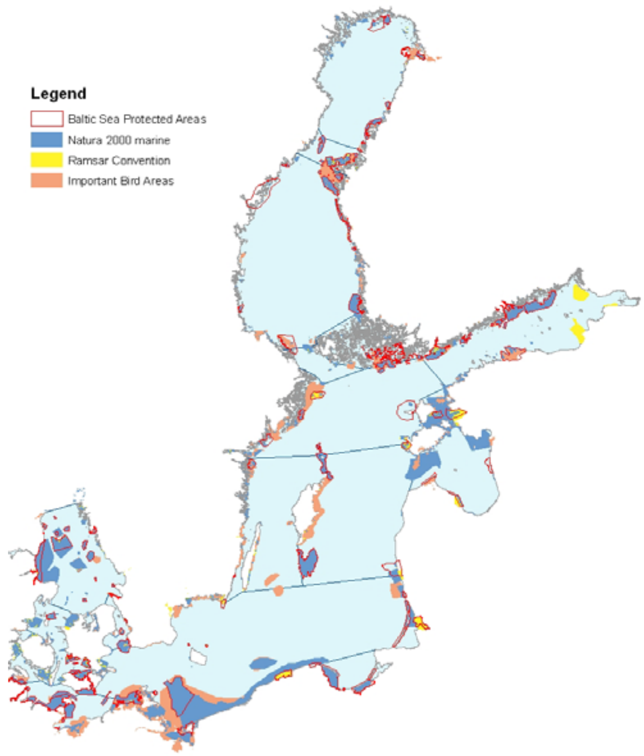

Fig. 1. Baltic Sea Protected Areas, Natura 2000 sites, Ramsar Convention sites and Important Bird Areas in the Baltic Sea as October 2008.

According to a HELCOM and OSPAR Joint Work Programme (2003), the network of Baltic Sea Protected Areas (BSPA) should be well-managed and ecologically coherent by 2010. At present, many sites still lack implemented management plans, though progress is being made in many countries. In order to facilitate the preparations of management plans, HELCOM has developed Guidelines for good management[23].

[21] http://www.helcom.fi/Recommendations/en_GB/rec15_5/
[22] http://bspa.helcom.fi
[23] http://www.helcom.fi/Recommendations/guidelines/en_GB/guidel_15_5_mgt/

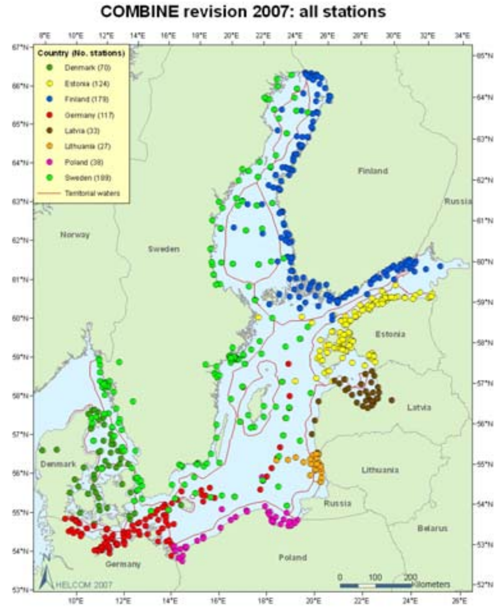

Fig. 2. All HELCOM monitoring stations in 2007.

A recent HELCOM assessment (Appendix 2) identified that the BSPA network does not adequately cover all the features of the Baltic marine environment. In order to fill this gap, it was decided in the BSAP to designate new areas, particularly in offshore waters, and as appropriate to nominate Natura 2000 sites as BSPAs. In order to support Contracting Parties to nominate new areas, HELCOM has produced Guidelines for the designation of BSPAs[24]. HELCOM has also participated in a recent international EU-funded project (BALANCE) to model underwater and coastal features of the Baltic Sea area, and GIS-based tools for assessing the ecological coherence of the MPA networks exist in the region, thus supporting decision making in the planning of new protected areas.

HELCOM co-ordinate harmonised open water monitoring in the region, covering also large marine areas inside the BSPAs (Figure 2). The HELCOM monitoring programme covers hydrography, phytoplankton, zooplankton, macrophytobenthos, zoobenthos and some chemical parameters. The whole set of parameters is not measured at all the stations[25]. However, there is no specific monitoring of HELCOM Baltic Sea Protected Areas.

The monitoring of habitats, coastal vegetation, terrestrial fauna and birds is done for the EU Natura 2000 network by each EU Member State[26].

6. Theme 4: Mariculture

The only major form of mariculture in the Baltic Sea is the farming of rainbow trout. Mussel farming takes place in Kattegat. According to research done on fish farm sites, the eutrophicating effect is limited mainly to the adjacent water mass. Although farmed rainbow trout regularly escape from farms, they have not become established in the Baltic ecosystem. Because fish farms can degrade coastal underwater habitats by producing excessive amounts of organic matter, they are strictly regulated by authorities. HELCOM has also adopted a recommendation with measures aimed at reducing discharges from fish farms.[27]

7. Theme 5: Alien species

Alien species are a major threat to the Baltic Sea ecosystem. Increased maritime traffic has rapidly brought new species to the area, of which many have become established, some have rapidly invaded adjacent areas, and some have replaced native species. According to the *Baltic Sea Alien Species Database* 120 non-native aquatic species have been recorded in the Baltic Sea area, of which 80 have established viable populations in some parts of the sea area. Many of the species have apparently benefited from the deteriorated state of coastal waters, but others have spread also to

[24] http://www.helcom.fi/Recommendations/guidelines/en_GB/guide15_5/
[25] Monitoring stations in the GIS interface: http://www.helcom.fi/gis/en_GB/HelcomGIS/
[26] Eight out of HELCOM's nine Contracting States are members of the EU.
[27] HELCOM Recommendation 25/4, http://www.helcom.fi/Recommendations/en_GB/rec25_4/

more pristine areas. So far, the southern Baltic Sea has faced the greatest pressure by invasions, but in recent years some of these species have also become established in the northern sea areas.

The HELCOM Contracting States have together acted to minimise the threat from non-indigeneous species, e.g by agreeing to ratify by 2010, or at the latest by 2013, the 2004 International Convention on the Control and Management of Ships' Ballast Water and Sediments (BWM Convention). To facilitate ratification, the HELCOM Ballast Water Road Map[28] was adopted as a part of the HELCOM Baltic Sea Action Plan. As a first step in the road map, HELCOM has adopted a list of potential invader species and their characteristics and a list containing the non-indegeneous species currently found from the area. Moreover, the road map contains actions *inter alia* to establish exchange of information among authorities, compile hydrographic information from major ports and make risk assessments for certain ship routes.

As part of this process HELCOM is jointly with OSPAR requesting vessels transiting the Atlantic or entering the North-East Atlantic from routes passing the West African Coast to conduct on a voluntary basis ballast water exchange before arriving in the OSPAR area or passing through the OSPAR area and heading to HELCOM area, the Baltic Sea. The joint OSPAR/HELCOM General Guidance on the Voluntary Interim application of the D1 Ballast Water Exchange Standard in the North-East Atlantic[29] has been applied from 1 April 2008 and the International Maritime Organization (IMO) has issued a circular on this.

8. Conclusions

HELCOM is currently finalising its first thematic assessment on the biodiversity of the Baltic Sea. The assessment addresses the major threats and presures to the ecosystem, presents the status and trends of several components of the ecosystem from primary producers to marine mammals and summarises the key legal frameworks for regulating pressures or for protecting species, biotopes or habitats. With almost 35 years of experience in co-ordinating regional policies related to marine protection, HELCOM has provided a platform for intergovernmental co-operation and joint international efforts to monitor, protect and manage sustainably the Baltic marine environment.

[28] http://www.helcom.fi/BSAP/ActionPlan/otherDocs/en_GB/roadmap/
[29] http://www.helcom.fi/stc/files/Guidelines/2-8%20HELCOM&OSPAR%20Voluntary%20Guidance%20for%20Ballast%20Water%20Exchange.pdf

HELCOM Baltic Sea Action Plan

HELCOM Ministerial Meeting

Krakow, Poland, 15 November 2007

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HELCOM BALTIC SEA ACTION PLAN

adopted on 15 November 2007 in Krakow, Poland
by the HELCOM Extraordinary Ministerial Meeting

Preamble

The Commission, represented by

[the Minister for Environment of the Kingdom of Denmark,]

the Minister of Environment of the Republic of Estonia,

the Minister for Environment of the Republic of Finland,

the High Level Representative of the Federal Republic of Germany,

the Minister of the Republic of Latvia,

the Minister of Environment of the Republic of Lithuania,

the Minister for Environment of the Republic of Poland,

the High Level Representative of the Russian Federation,

the Minister for Environment of the Kingdom of Sweden;

and by the High Level Representative of the European Commission on behalf of the European Community

ASSEMBLED in Krakow, Poland on the occasion of the Extraordinary Ministerial Meeting of the Helsinki Commission, on 15 November 2007;

RECALLING the provisions of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992;

Especially BEING CONSCIOUS of the indispensable values of the unique marine ecosystem of the Baltic Sea area, its exceptional hydrographical and ecological characteristics and the particular sensitivity of its living resources to changes in the environment.

AWARE that HELCOM's work has led to significant environmental improvements in many areas, but that a large number of problems have yet to be fully addressed and that major threats still persist which are hindering restoration, protection and sustainable utilisation of the marine goods and services provided by the Baltic Sea;

FULLY AWARE that climate change will have a significant impact on the Baltic Sea ecosystem requiring even more stringent actions in the future and of the efforts made by the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change;

RECALLING the 2003 Declaration of the First Joint Ministerial Meeting of the Helsinki and OSPAR Commissions to apply and further develop the measures necessary to implement an ecosystem approach to the management of human activities;

ACKNOWLEDGING that the ecosystem approach is based on an integrated management of all human activities impacting on the marine environment and, based on best available scientific knowledge about the ecosystem and its dynamics, identifies and leads to actions improving the health of the marine ecosystem thus supporting sustainable use of ecosystem goods and services;

STRESSING the need for integrated management of human activities and the need to take into account their impacts on the marine environment in all policies and programmes implemented in the Baltic Sea region;

FURTHERMORE STRESSING the need for integration of environmental objectives with economic and socio-economic goals in order to advance and strengthen the three interdependent pillars of sustainable development;

RECALLING the adopted HELCOM vision "A healthy Baltic Sea environment, with diverse biological components functioning in balance, resulting in a good environmental/ecological status and supporting a wide range of sustainable human economic and social activities" having biodiversity at its core and which builds upon concepts such as "favourable conservation status" and "good ecological and good environmental status";

FURTHER RECALLING that based on HELCOM monitoring and assessment work on the state of the Baltic marine environment four strategic goals, reflecting the jointly identified major environmental problems in the Baltic Sea, have been adopted describing the desired state of the marine environment, namely a "Baltic Sea unaffected by eutrophication", "Baltic Sea with life undisturbed by hazardous substances", "Maritime activities carried out in an environmentally friendly way", all of which will lead to a "Favourable conservation status of Baltic Sea biodiversity";

FURTHERMORE RECALLING the adopted HELCOM ecological objectives which describe the good environmental/ecological status we want to achieve for the Baltic Sea in the future;

AGREEING that the targets, which are associated with the ecological objectives, are defining the good environmental/ecological status of the Baltic Sea;

AGREEING that the management decisions are based on sub-regional targets;

FURTHER AGREEING that when selecting the necessary management measures within different sectors focus shall be put on cost-benefits and cost-efficiency taking into account economic and social sustainability in the Baltic Sea Region;

BEING AWARE that there are cost implications of not taking actions against eutrophication and other threats to the Baltic Sea;

FURTHERMORE AGREEING that the effectiveness of the actions taken shall be evaluated by using appropriate indicators to measure the progress towards the targets. This will allow future adjustments of the actions to ensure that the objectives will be achieved;

ACKNOWLEDGING that the current environmental as well as reduction targets in the various segments are based on best available knowledge of today. Pursuing the adaptive management principles, the objectives and targets should be periodically reviewed and revised using a harmonised approach and most updated information;

STRESSING that HELCOM's monitoring and assessment programme will contribute to an improved scientific understanding of the marine environment that will in turn contribute to the periodic review of the objectives, associated targets and indicators, and will be decisive when determining the need for further management measures;

FURTHER STRESSING the need to co-ordinate and harmonise the work within the HELCOM Baltic Sea Action Plan to various on-going initiatives at the international and national level, including the proposed EU Marine Strategy Directive, the EU Maritime Policy and the Maritime Doctrine of the Russian Federation;

FURTHERMORE STRESSING the need to make use of common Baltic knowledge and priorities in policy making at the global, regional and national level when deciding on the needed actions to reach the good environmental/ecological status of the Baltic Sea;

APPRECIATING the positive contributions made by Intergovernmental Organisations and Non-governmental Organisations within their work and within the work of HELCOM towards preserving and protecting the Baltic Sea Area and ensuring a prudent utilisation of its marine goods and services;

WITHOUT PREJUDICE TO international agreements and legislation of the European Community;

HAS AGREED TO THE FOLLOWING ACTIONS TO ACHIEVE A BALTIC SEA IN GOOD ENVIRONMENTAL STATUS BY 2021:

Eutrophication segment of the HELCOM Baltic Sea Action Plan

Eutrophication segment of the HELCOM Baltic Sea Action Plan

Eutrophication – towards a Baltic Sea unaffected by eutrophication

Introduction

The overall goal of HELCOM is to have a Baltic Sea unaffected by eutrophication.

Eutrophication is a major problem in the Baltic Sea. Since the 1900s, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment. Eutrophication is a condition in an aquatic ecosystem where high nutrient concentrations stimulate the growth of algae which leads to imbalanced functioning of the system, such as:

- intense algal growth: excess of filamentous algae and phytoplankton blooms;
- production of excess organic matter;
- increase in oxygen consumption;
- oxygen depletion with recurrent internal loading of nutrients; and
- death of benthic organisms, including fish.

Excessive nitrogen and phosphorus loads coming from land-based sources, within and outside the catchment area of the Contracting States, are the main cause of the eutrophication of the Baltic Sea. About 75% of the nitrogen load and at least 95% of the phosphorus load enter the Baltic Sea via rivers or as direct waterborne discharges. About 25% of the nitrogen load comes as atmospheric deposition.

Ecological objectives

The aim is to reach HELCOM's vision for good environmental status in the Baltic Sea. For this reason HELCOM has adopted the following ecological objectives to describe the characteristics of a Baltic Sea, which is unaffected by eutrophication:

- Concentrations of nutrients close to natural levels,
- Clear water,
- Natural level of algal blooms,
- Natural distribution and occurrence of plants and animals,
- Natural oxygen levels.

In order for the ecological objectives to be made operational, indicators with target values, reflecting good ecological and environmental status of the Baltic marine environment, have been agreed upon. Clear water was chosen as the primary ecological objective with water transparency as the indicator (see page 76).

Cross-references with other objectives

Failure to reach the objectives for eutrophication will impair the achievement of favourable status of biodiversity.

At the same time the management objectives for airborne nitrogen emissions from shipping and nutrient inputs from ships' untreated sewage are also relevant for reaching the objectives with regard to eutrophication.

In order to reach the goal towards a Baltic Sea unaffected by eutrophication

WE AGREE on the principle of identifying maximum allowable inputs of nutrients in order to reach good environmental status of the Baltic Sea,

WE ALSO AGREE that there is a need to reduce the nutrient inputs and that the needed reductions shall be fairly shared by all Baltic Sea countries,

BEARING IN MIND that the figures are based on the MARE NEST model, the best available scientific information, and thus stressing the provisional character of the data **WE ACKNOWLEDGE** that the maximum nutrient input to the Baltic Sea that can be allowed and still reach good environmental status with regard to eutrophication is about 21,000 tonnes of phosphorus and 600,000 tonnes of nitrogen,

WE FURTHERMORE RECOGNISE that, based on national data or information from 1997-2003 in each sub-region of the Baltic Sea, the maximum allowable nutrient inputs to reach good environmental status and the corresponding nutrient reductions that are needed in each sub-region are as follows:

Sub-region	**Maximum allowable nutrient input (tonnes)**		**Inputs in 1997-2003 (normalised by hydrological factors)**		**Needed reductions**	
	Phosphorus	Nitrogen	Phosphorus	Nitrogen	Phosphorus	Nitrogen
Bothnian Bay	2,580	51,440	2,580	51,440	0	0
Bothnian Sea	2,460	56,790	2,460	56,790	0	0
Gulf of Finland	4,860	106,680	6,860	112,680	2,000	6,000
Baltic Proper	6,750	233,250	19,250	327,260	12,500	94,000
Gulf of Riga	1,430	78,400	2,180	78,400	750	0
Danish straits	1,410	30,890	1,410	45,890	0	15,000
Kattegat	1,570	44,260	1,570	64,260	0	20,000
Total	21,060	601,720	36,310	736,720	15,250	135,000

In order to diminish nutrient inputs to the Baltic Sea to the maximum allowable level **WE AGREE** to take actions not later than 2016 to reduce the nutrient load from waterborne and airborne inputs aiming at reaching good ecological and environmental status by 2021,

WE AGREE on the following country-wise provisional nutrient reduction requirements:*

	Phosphorus (tonnes)	Nitrogen (tonnes)
Denmark	16	17,210
Estonia	220	900
Finland	150	1,200
Germany	240	5,620
Latvia	300	2,560
Lithuania	880	11,750
Poland	8,760	62,400
Russia	2,500	6,970
Sweden	290	20,780
Transboundary Common pool	1,660	3,780

WE ACKNOWLEDGE that the current environmental and nutrient reduction targets presented above are provisional, though based on best available knowledge of today. Pursuing the adaptive management principles, all the figures related to targets and maximum allowable nutrient inputs should be periodically reviewed and revised using a harmonised approach using updated information to be made available by the Contracting States and starting in year 2008 taking into account the results of the Fifth Pollution Load Compilation (PLC-5) and national river basin management plans,

WE RECOGNISE that the reduction of water- and airborne inputs of nutrients within a HELCOM Contracting State contributing to the achievement of country-wise reduction targets should be accounted for,

In order to reach the above country-wise provisional reduction targets **WE AGREE** to develop and to submit for HELCOM's assessment national programmes by 2010 with a view to evaluate the effectiveness of the programmes at a HELCOM Ministerial Meeting in 2013 and whether additional measures are needed. **WE ACKNOWLEDGE** that this approach would leave enough flexibility for the countries to choose the cost-effective measures to be implemented to reach the reduction targets in order to achieve a good ecological and environmental status of the Baltic Sea with regard to eutrophication.

FURTHERMORE WE AGREE TO identify and where appropriate to include the required and appropriate measures into national programmes / River Basin Management Plans of the EU Water Framework Directive (Directive 2000/60/EC) for HELCOM Contracting States that are also EU Member States.

In order to cut the nutrient load from waterborne inputs

WE ADOPT the following two Recommendations on wastewater treatment which – if fully implemented – have an estimated capacity to reduce the current total nutrient input to the Baltic Sea including 6,700 tonnes phosphorus which means an additional 2,000 tonnes compared to existing requirements:

- HELCOM RECOMMENDATION 28E/5 on more stringent requirements for P-removal from municipal wastewater treatment plants (above 10,000 p.e.) and introduction of requirements for wastewater management for small- and medium-sized municipalities (300-10,000 p. e.);
- HELCOM RECOMMENDATION 28E/6 on improvement of on-site wastewater treatment of single-family homes, small businesses and settlements up to 300 p.e.,

* *Finland informs that the reduction needs for the Archipelago Sea, which have not been sufficiently taken into account using the MARE NEST model will be addressed according to national plans.*

Furthermore **WE AGREE** that, in order to achieve country-wise nutrient reduction targets, the Contracting States should choose the most appropriate and cost-effective measures taking into account requirements of the two aforementioned Recommendations and include them into national programmes.

WE FURTHERMORE ADOPT HELCOM RECOMMENDATION 28E/7 on Measures aimed at the substitution of phosphorus in detergents,

WE ACKNOWLEDGE that agriculture is the main source of nutrient inputs to the Baltic Sea, and

WE FURTHERMORE CONSIDER that nutrient losses from urban as well as scattered settlements will be reduced to an acceptable level with full implementation of the above recommendations and that the agricultural sector is the land-based source where major reductions are needed, and to this end,

WE AGREE to take all necessary steps towards designating relevant parts of agricultural land in the catchment area as a zone vulnerable to nitrates,

WE AGREE to amend Annex III part II Prevention of pollution from Agriculture of the Convention by adopting HELCOM RECOMMENDATION 28E/4 and **EMPHASISE** the need for proper implementation of its requirements and to apply agricultural Best Environmental Practice (BEP) and Best Available Technology (BAT),

WE ENDORSE the HELCOM list of examples for measures for reducing phosphorus and nitrogen losses from agriculture as contained on page 86,

FURTHERMORE WE AGREE to establish by 2009 a list of Hot Spots identifying existing installations for the intensive rearing of cattle, poultry and pigs not fulfilling the requirements in the revised Annex III of the Convention,

Contracting States which are also Member States of the EU **WELCOME** that the European Commission is about to adopt a communication on the Health Check of the EU Common Agricultural Policy which will trigger a broad EU-wide consultation process, and **AGREE** within the given deadline to make a joint submission stressing the need to integrate better the specific environmental concerns of the Baltic Sea, and the need to adopt additional and targeted agricultural measures in particular to reduce eutrophication of the Baltic Sea,

WE AGREE on the need to address also other sources which can have significant eutrophication impacts such as forestry, peat mining, aquaculture and fur farming,

WE RECOGNISE the increased production of energy crops and **AGREE** on the need to apply adequate water protection requirements,

WE ALSO ACKNOWLEDGE that an estimated amount of 1,660 tonnes of phosphorus and 3,780 tonnes of nitrogen coming from transboundary waterborne pollution originating in Belarus should be allocated to a common pool. **WE AGREE** that transboundary pollution originating in the non-Contracting States Belarus and Ukraine should be addressed by initiating joint activities e.g. by bi- and/or multilateral projects and through other existing funding mechanisms as well as by international agreements such as the 1992 UNECE Convention on Transboundary Waters and Lakes, and the River Basin Management Plans of the EU Water Framework Directive for HELCOM Contracting States being also EU Member States,

In order to cut the nutrient load from airborne inputs

WE ACKNOWLEDGE that a quarter of the total nitrogen input to the Baltic Sea is airborne of which sources outside the Baltic Sea catchment area contribute about 40% of the direct nitrogen deposition, and therefore,

WE DECIDE that the governments of the HELCOM Contracting Parties shall make use of the assessments of the inputs and effects of airborne nitrogen to the Baltic Sea in the revision of the emission targets for nitrogen under the 1979 UNECE Convention for Long-Range Transboundary Air Pollution, and

WE AGREE that HELCOM Contracting States that are also EU Member States, in order to strengthen the emission targets for nitrogen under the EU National Emissions Ceilings Directive (Directive 2001/81/EC), will aim to include also emissions from ships and the achievement of ecological objectives for eutrophication in the marine environment.

WE ALSO AGREE that all HELCOM Contracting Parties will aim to do so likewise for the emission targets in the 1999 Gothenburg Protocol under the UNECE Convention for Long-Range Transboundary Air Pollution.

Hazardous substances segment of the HELCOM Baltic Sea Action Plan

Hazardous substances segment of the HELCOM Baltic Sea Action Plan

Hazardous Substances – towards a Baltic Sea with life undisturbed by hazardous substances

Introduction

The overall HELCOM goal is to achieve a Baltic Sea with life undisturbed by hazardous substances.

Pollution caused by hazardous substances refers to a massive number of different anthropogenic substances ending up in the marine environment including substances that do not occur naturally in the environment and substances occurring at concentrations exceeding natural levels. Although monitoring indicates that the loads of some hazardous substances have been reduced considerably over the past 20–30 years, problems still persist, and concentrations in the marine environment of some new substances have even increased (e.g. perfluorinated substances).

Once released into the Baltic Sea, hazardous substances can remain in the marine environment for very long periods and can accumulate in the marine food web up to levels which are toxic to marine organisms. Levels of some hazardous substances in the Baltic Sea exceed concentrations in e.g. the North East Atlantic by more than 20 times. Hazardous substances cause adverse effects on the ecosystem, such as

- Impaired general health status of animals;
- Impaired reproduction of animals, especially top predators;
- Increased pollutant levels in fish for human food.

Some fish species caught in some parts of the Baltic Sea are not suitable for human consumption as they contain hazardous substances exceeding established concentration levels. Certain contaminants may be hazardous because of their effects on hormone and immune systems, as well as their toxicity, persistence and bio-accumulating properties.

Within HELCOM substances are defined as hazardous if they are toxic, persistent and bio-accumulative (PBT-substances), or very persistent and very bio-accumulative (vPvB). Moreover, substances having an equivalent level of concern such as substances with effects on hormone and immune systems are also hazardous substances.

Especially substances which are persistent and bio-accumulative may cause potential hazards to humans.

Ecological objectives

The agreed goal of HELCOM on hazardous substances is a *Baltic Sea undisturbed by hazardous substances.*

The goal is described by four ecological objectives:

- Concentrations of hazardous substances close to natural levels,
- All fish safe to eat
- Healthy wildlife,
- Radioactivity at pre-Chernobyl level.

In order for the ecological objectives to be operational, indicators with targets, reflecting good ecological and environmental status of the Baltic marine environment, have been agreed upon as contained on page 81.

Cross-references with other objectives

Failure to reach the objectives for hazardous substances will impair the achievement of favourable status of biodiversity.

At the same time the achievement of management objectives for Eutrophication and Maritime Activities will have an impact on reaching the goal of a Baltic Sea undisturbed by hazardous substances.

Taking into account the potential hazard of the substances of specific concern to the Baltic Sea marine environment, the substances on page 77 were selected for inclusion in the Baltic Sea Action Plan acknowledging the possible revision of the list and the actions in the future when more information will be available.

In order to address specific sources of hazardous substances and to reach the goal of a Baltic Sea with life undisturbed by hazardous substances

WE ADOPT HELCOM RECOMMENDATION 28E/8 concerning environmentally friendly practices for the reduction and prevention of emissions of dioxins and other hazardous substances from small-scale combustion.

In relation to the HELCOM Recommendation 28E/8, **WE FURTHER AGREE** to develop in 2008 specific efficiency requirements and emission limit values for small scale combustion appliances.

In order to address identified important sources of hazardous substances **WE AGREE** to update HELCOM Recommendation 19/5 on the HELCOM Strategy for hazardous substances and HELCOM Recommendation 24/5 concerning Proper handling of waste/landfilling as well as HELCOM Recommendation 24/4 for the iron and steel industry,

Taking into account the importance of reducing heavy metal and other hazardous substances emissions from energy production and industrial combustion plants, **WE AGREE** by 2008 to evaluate the need to develop further requirements in these sectors,

WE AGREE to develop and to submit for HELCOM's assessment national implementation programmes by 2010 with a view to evaluating the effectiveness of the programmes at a Ministerial Meeting in 2013 and to further evaluate whether additional measures are needed either on a national, HELCOM or global level. In developing the programmes we agree to take into account the need for:

- identification of sources of the selected hazardous substances or substance groups (taking also into account the relevant sectors as contained in other documents section, page 78);
- a ban or restrictions on the use of identified relevant hazardous substances or substance groups;
- substitution of the selected hazardous substances or substance groups with less hazardous substances;
- development of technical guidance documents for environmental permitting addressing hazardous substances;
- capacity building for authorities and industries with regard to identification of hazardous substances and the possibilities for elimination of the use of substances as well as application of BEP and BAT;
- raising awareness among consumers by arranging campaigns and disseminating information about environmentally friendly products;
- relevant legislation including a proper definition of hazardous substances;

WE AGREE to further identify, estimate and reduce the discharges, emissions and losses from sources within the identified potential sectors and main uses and include them into national implementation programmes/ Programmes of measures under the EU Water Framework Directive for HELCOM Contracting States that are also EU Member States. The selected hazardous substances or substance groups as on page 77 will be taken into account when environmental permits will be established or renewed for different industrial activities and municipal wastewater treatment plants and municipal landfill sites where the substances or the substance groups potentially occur. BAT and BEP are to be applied where hazardous substances might be released. Furthermore, co-operation will be developed for a mutual information exchange on hazardous substances with the European Chemical Agency in Helsinki,

WE ALSO AGREE that screening and assessment of the occurrence and effects of a subset of the selected hazardous substances in the Baltic Sea marine environment will be started in 2008, in co-operation with the Nordic Council of Ministers, in order to further develop measures for selected substances,

WE FURTHER AGREE as soon as possible, but not later than in the beginning of 2009, that the screening of the occurrence and effects in the environment should be complemented with screening of the sources of selected substances in municipal and industrial wastewaters as well as landfill effluents and storm waters,

WE AGREE to evaluate as soon as possible, but not later than in the beginning of 2009, the practical introduction of the whole effluent assessment (WEA) approach to monitoring of complex discharges of hazardous substances into the HELCOM framework and to establish a pilot project to test some of the presented methods by making a survey in the HELCOM countries in municipal wastewater treatment plants and some specific industrial sectors. The outcome of this pilot project should be used to evaluate the effluents jointly for the Baltic Sea region and to possibly establish PBT (persistent, bioaccumulating, toxic)-based discharge limit values based on the WEA approach,

WE AGREE by 2010 to establish and develop appropriate chemical product registers in order to have more reliable substance-specific information on uses and amounts of chemicals used. It has to be taken into account that existing registers and those under development should be used as much as possible and the respective developments under e.g. the EU regulatory framework for Registration, Evaluation, Authorisation and Restriction of Chemicals, REACH (EC1907/2006) should be built upon,

WE AGREE to use the information created through implementation of the EU chemicals legislation REACH in order to decrease pollution caused by hazardous substances to the Baltic marine environment for HELCOM Contracting States that are also EU Member States**,**

WE ALSO AGREE by 2009 if relevant assessments show the need to initiate adequate measures such as the introduction of use restrictions and substitutions in the most important sectors identified by the Contracting Parties and taking as a starting point the list as contained in the other document section (page 78)

- medium-chain chlorinated paraffins (MCCPs)
- octylphenols (OP)/Octylphenol ethoxylates (OPE)
- perfluorooctanoic acid (PFOA)
- decabromodiphenyl ether (decaBDE),

and **WE ALSO AGREE** to consider similar approaches with regard to hexabromocyclododecane (HBCDD)

WE AGREE by 2010 in the whole Baltic Sea catchment area of the Contracting States to ban the use, production and marketing of (taking into account the as contained in the other document section (page 78)

- endosulfan
- pentabromodiphenylether (pentaBDE) and

- octabromodiphenylether (octaBDE),

WE AGREE to start by 2008 to work for strict restrictions on the use in the whole Baltic Sea catchment area of the Contracting States of (taking into account the information as contained in the other document section (page 78):

- perfluorooctane sulfonate (PFOS)
- nonylphenol/nonylphenolethoxylates (NP/NPEs)
- Short-chain chlorinated paraffins (SCCPs),

WE AGREE to assess by 2009 the possibility of introducing restrictions for cadmium content in fertilisers,

WE AGREE to apply strict restrictions on the use of mercury in products and from processes and support the work towards further limiting and where feasible totally banning mercury in products and from processes. **WE FURTHERMORE AGREE** to review this issue at the 2010 HELCOM Ministerial Meeting,

WE AGREE on the need to apply the same requirements for products marketed globally as in the internal European market concerning hazardous substances,

WE AGREE to implement as soon as possible the Globally Harmonised System (GHS) on classification and labelling of chemicals and to take into account guidelines for preparing safety data sheets,

WE ALSO EMPHASISE the importance of influencing ongoing work on hazardous substances in other international forums by coherent input by HELCOM Contracting States, where possible based on a common HELCOM position:

- to the development of EU BAT Reference Documents (BREFs) in order to enhance implementation of BAT with regard to hazardous substances with special focus on main uses or on uses having high emission factor to the environment
- to the updating of the EU Water Framework Directive list of priority substances and substances to be evaluated under REACH with a special focus on those substances included in Annex XIV of the EU chemicals legislation REACH for those Contracting States that are also EU Member States including by transmitting monitoring data to the European Chemical Agency
- on placing of plant protection and biocides products on the market, if e.g. levels of these substances in the Baltic marine environment are so high that they may cause adverse effects on marine organisms,

WE FURTHERMORE AGREE to promote and support the identification of new candidate substances and their inclusion in the 2001 Stockholm Convention on Persistent Organic Pollutants and the 1998 Aarhus Protocol on Persistent Organic Pollutants to the UNECE Convention on Long-Range Transboundary Air Pollution, taking into account adequate assessments in particular on their impact on the marine environment,

WE AGREE that all Contracting Parties ratify the 2001 Stockholm Convention on Persistent Organic Pollutants and the 1998 Aarhus Protocol on Persistent Organic Pollutants to the UNECE Convention on Long-Range Transboundary Air Pollution as soon as possible but not later than 2010,

WE AGREE to promote the Strategic Approach on International Chemicals Management and participate in the regional implementation process as soon as possible but not later that 2010,

WE FURTHER AGREE starting in 2008 to develop biological effects monitoring to facilitate a reliable ecosystem health assessment,

WE FURTHER AGREE to continue HELCOM’s work with regard to radioactivity, including monitoring of discharges, emissions from nuclear power plants as well as their effects in the marine environment in order to reach the targets for radioactivity.

Biodiversity and nature conservation segment of the HELCOM Baltic Sea Action Plan

Biodiversity and nature conservation segment of the HELCOM Baltic Sea Action Plan

Biodiversity – towards a favourable conservation status of Baltic Sea biodiversity

Introduction

The Baltic Sea has a unique combination of marine and freshwater species and habitats adapted to brackish conditions. Favourable conservation status of Baltic Sea biodiversity is a prerequisite for the marine ecosystems to be resilient and able to adapt to changing environmental conditions.

The Baltic Sea Action Plan aims at aligning the goal “favourable conservation status of marine biodiversity” with corresponding goals and objectives of already existing regulations which also address biodiversity and nature conservation.

This section of the Baltic Sea Action Plan contributes to the implementation of commitments made through global agreements related to the protection of biodiversity such as the 2002 World Summit on Sustainable Development (WSSD), the 1992 Convention on Biological Diversity, the 1971 Ramsar Convention on Wetlands, the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats, the 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals, and the EU Habitats Directive (Directive 92/43/EEC), Birds Directive (Directive 79/409/EEC), EU Water Framework Directive, the proposed Marine Strategy Directive, and national legislation.

Ecological objectives

In order to reach favourable conservation status of biodiversity, HELCOM has adopted Ecological Objectives covering topics referring to:

- restoring and maintaining sea floor integrity at a level that safeguards the functions of the ecosystems;
- that habitats, including associated species, show a distribution, abundance and quality in line with prevailing physiographic, geographic and climatic conditions; and
- a water quality that enables the integrity, structure and functioning of the ecosystem to be maintained or recovered.

In accordance with the Convention on Biological Diversity, HELCOM’s overall goal of a favourable conservation status of Baltic Sea biodiversity is described by the following three ecological objectives:

- natural marine and coastal landscapes,
- thriving and balanced communities of plants and animals, as well as
- viable populations of species.

In order to make the ecological objectives operational and to assess how the objectives have been achieved, the initial targets and indicators as on page 83 will be used.

Cross-references with other objectives

Since a multitude of human activities have impacts on biodiversity and the biodiversity serves as a holistic controlling element for the performance of the whole Action Plan, the goal “favourable conservation status of the Baltic Sea biodiversity” cannot be reached without a broad consideration of human activities and needs for strong actions in other segments. Reduced eutrophication will decrease algal blooms, suffocating growth of filamentous littoral algae and anoxic bottoms, and making possible the natural distribution and occurrence of natural marine landscapes, habitats, and plant and animal species. Minimised concentrations of hazardous substances in the biota are a prerequisite for a healthy wildlife, i.e. viable populations in the

Baltic Sea. Enhancing the safety of navigation will decrease the probability of environmental stress caused by minor and severe oil spills. Actions aiming at prevention of pollution from ships as well as the prevention of introduction of alien species are needed to reach favourable conservation status.

To reach the targets and objectives associated with the favourable conservation status of Baltic Sea biodiversity

WE AGREE to jointly develop by 2010, as well as test, apply and evaluate by 2012, in co-operation with other relevant international bodies, broad-scale, cross-sectoral, marine spatial planning principles based on the Ecosystem Approach:

- whereby all Contracting Parties and relevant HELCOM bodies shall co-operatively participate;
- thereby giving guidance for the planning and ensuring the protection of the marine environment and nature, including habitats and seafloor integrity;
- securing sustainable use of marine resources by reducing user conflicts and adverse impacts of human activities,

WE NOTE in this respect the results of the INTERREG-IIIB BALANCE Project related to spatial planning,

To this end **WE ADOPT** HELCOM RECOMMENDATION 28E/9 on development of broad-scale marine spatial planning principles in the Baltic Sea area on page 57,

WE DECIDE to designate by 2009 already established marine Natura 2000 and Emerald sites, where appropriate, as HELCOM Baltic Sea Protected Areas (BSPAs) and to designate by 2010 additional BSPAs especially in the offshore areas beyond territorial waters bearing in mind the 2012 target of the UN WSSD Johannesburg Declaration and the Convention on Biological Diversity,

WE AGREE to improve the protection efficiency of the BSPA network by 2010

- by assessing the ecological coherence of the BSPA network together with the marine Natura 2000 and Emerald sites;
- by finalising, where possible, and implementing management plans,

WE ACKNOWLEDGE the need for further research to reach the targets and objectives associated with the favourable conservation status of the Baltic Sea biodiversity,

Therefore **WE AGREE** to increase knowledge on and protection of Baltic Sea marine habitats, communities and species

- by 2011 by updating a complete classification system for Baltic marine habitats/biotopes;
- by 2013 by updating HELCOM Red lists of Baltic habitats/biotopes and biotope complexes, and producing a comprehensive HELCOM Red list of Baltic Sea species;
- by developing further, where appropriate and needed, detailed landscape maps of the Baltic Sea area based on existing information;
- by 2013 by identifying and mapping the potential and actual habitats formed by species such as bladderwrack (*Fucus* spp.), eelgrass (*Zostera marina*), blue mussel (*Mytilus* spp.), *Furcellaria lumbricalis* and stoneworts (Charales) as well as recruitment habitats for coastal fish using modelling among other tools, and to develop a common approach for the mitigation of negative impacts;
- by developing research on possibilities of reintroduction of valuable phytobenthos species in regions of their historical occurrence especially in degraded shallow waterbodies in the southern Baltic Sea;
- by 2011 by producing, in co-operation with relevant organisations, an assessment of the conservation status of non-commercial fish species;

- by 2010 by further developing in co-operation with the 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) a co-ordinated reporting system and database on Baltic harbour porpoise sightings, by-catches and strandings;
- by the promotion of research aiming at developing additional methods for the assessment of, and reporting on, the impacts of fisheries on biodiversity;
- by the development and implementation of effective monitoring and reporting systems for by-caught birds and mammals;

WE FURTHER REQUEST the competent authorities, in co-operation with the Baltic Regional Advisory Council (RAC) under the EU Common Fisheries Policy and HELCOM, to collaborate closely with the Contracting Parties in developing and implementing management measures for fisheries inside marine protected areas in the Baltic Sea area in order to fulfil conservation targets by 2010,

WE AGREE to safeguard the long-term viability of the Baltic seal populations according to HELCOM Recommendation 27-28/2, by following its general management principles, and by 2012, to finalise national management plans and by implementation of non-lethal mitigation measures for seals-fisheries interactions,

WE AGREE that the Baltic Sea shall become a model of good management of human activities, and recommend that all fisheries management be developed and implemented based on the Ecosystem Approach in order to enhance the balance between sustainable use and protection of marine natural resources,

WE ARE AWARE that this aim can be only achieved in co-operation with all Contracting Parties and Observers to HELCOM,

WE URGE competent fisheries authorities to take all the necessary measures to ensure that, by 2021, populations of all commercially exploited fish species are within safe biological limits, reach Maximum Sustainable Yield, and are distributed through their natural range, and contain full size/age range,

Therefore, **WE URGE** the competent fisheries authorities in co-operation with the Baltic RAC and HELCOM to take immediate actions for:

- development of long-term management plans for commercially exploited fish stocks so that they are within safe biological limits and reach agreed targets, such as Maximum Sustainable Yield (MSY), and improve their distribution and size/age-range, especially for salmon, sea trout, pelagic species (sprat and herring), and flatfish species, by 2010;
- introduction of additional fisheries management measures based on the best available scientific evidence to achieve:
  - that all caught species and by-catch which cannot be released alive or without injuries are landed and reported, by 2012;
  - continued designation of additional/improved spatial and/or temporal closures of sufficient size and duration for fisheries to prevent capture of spawning and juvenile fish;
  - the designation of additional permanent closures of sufficient size for fisheries to prevent capture of non-target species to protect important reproduction and feeding areas and to protect ecosystems, by 2012;
  - the further development and application in all cases of appropriate breeding and restocking practices for salmon and sea trout to safeguard the genetic variability of native wild stocks, by 2012;
  - the urgent adoption of measures to minimise by-catch of undersized fish and non-target species by 2012,

- by an evaluation of the effectiveness of existing technical measures, by 2008, to minimise by-catch of harbour porpoises, and to introduce adequate new technologies and measures.

WE also URGE the competent authorities to take actions for:

- immediate elimination of illegal, unregulated and unreported (IUU) fisheries and further development of landing control and other measures, taking into account the outcome of the Baltic RAC Conference on Control and Compliance in the Baltic in March 2007;
- rapid implementation of the existing long-term management plans for cod and eel, not later than by 2012 to improve their distribution size/age-range;

WE FURTHER AGREE to invite the competent authorities to apply, in relation to the recommendation above, the targets annexed to the Baltic Sea Action Plan which require the implementation of fisheries management measures;

Contracting States that are also Member States of the EU **AGREE** to make a joint submission , in consultation with the Russian Federation, with the view to ensure that fisheries are managed in sustainable manner compatible with the environmental objectives of the HELCOM Baltic Sea Action Plan, to the 2012 review of the EU Common Fisheries Policy (CFP);

WE ALSO AGREE:

- to develop national programmes for the conservation of eel stocks as a contribution to a Baltic co-ordinated programme to ensure successful eel migrations from the Baltic Sea drainage basin to natural spawning grounds. For the EU Member States thus implementing the EC Regulation No. 1100/2007 establishing measures for the recovery of the stock of European eel, by 2008;
- the classification and inventorying of rivers with historic and existing migratory fish species (e.g. salmon, eel, sea trout and sturgeon), no later than by 2012;
- the development of restoration plans (including restoration of spawning sites and migration routes) in suitable rivers to reinstate migratory fish species, by 2010;
- the active conservation of at least ten endangered/threatened wild salmon river populations in the Baltic Sea region as well as the reintroduction of native Baltic Sea salmon in at least four potential salmon rivers, by 2009,

WE ALSO AGREE to enhance restoration of lost biodiversity by joining and/or supporting Poland and Germany in reintroducing Baltic sturgeon to its potential spawning rivers,

WE AGREE that coastal fish constitute an imperative part of the Baltic Sea total biodiversity and have a structuring role in coastal food webs. Furthermore, coastal fisheries are of great importance to the society from both a socio-economic and a cultural point of view,

WE ACKNOWLEDGE that a substantial part of the coastal fish community of the Baltic Sea consists of freshwater species, only managed at a national level,

WE AGREE and **INVITE** the competent authorities

- to establish an international co-operation network to agree on guidelines to promote the ecosystem-based management of coastal fisheries in the Baltic region;
- to develop long-term plans for, protecting, monitoring and sustainably managing coastal fish species, including the most threatened and/or declining, including anadromous ones (according to the HELCOM Red list of threatened and declining species of lampreys and fishes of the Baltic Sea, BSEP No. 109), by 2012,
- develop a suite of indicators with region-specific reference values and targets for coastal fish as well as tools for assessment and sustainable management of coastal fish by 2012.

Maritime activities segment of the HELCOM Baltic Sea Action Plan

Maritime Activities segment of the HELCOM Baltic Sea Action Plan

Towards a Baltic Sea with maritime activities carried out in an environmentally friendly way

Introduction

The strategic goal of HELCOM is to have maritime activities in the Baltic Sea carried out in an environmentally friendly way. It should be understood, however, that due to its international character shipping is regulated by global provisions accepted within the framework of the specialised organisation, notably the International Maritime Organization (IMO).

The Baltic Sea is one of the most intensively trafficked areas in the world. Both the number and the size of the ships, especially oil tankers, have been growing during the last years, and this trend is expected to continue.

This heavy traffic is being carried out within narrow straits and in shallow water, covered with ice for a long period, which makes the Baltic a difficult area to navigate and leads to traffic junctions and an increased risk of shipping incidents.

The main negative environmental effects of shipping and other activities at sea include pollution to the air, illegal and accidental discharge of oil, hazardous substances and other wastes, and introduction of alien organisms via ships' ballast water and hulls.

Management objectives

To reach the goal the following eight management objectives, indicating areas of major importance, have been agreed upon:

- Enforcement of international regulations - No illegal discharges
- Safe maritime traffic without accidental pollution
- Efficient emergency and response capability
- Minimum sewage pollution from ships
- No introductions of alien species from ships
- Minimum air pollution from ships
- Zero discharges from offshore platforms
- Minimum threats from offshore installations

These management objectives do not directly describe the good ecological and environmental state of the Baltic Sea, but they rather indicate the main areas of concern as to the human activity at sea and its possible negative impact.

Cross-reference with other objectives

Failure to reach the objectives for maritime activities will impair the achievement of a healthy Baltic Sea unaffected by eutrophication, with its life undisturbed by hazardous substances and with favourable status of biodiversity.

More specifically, actions to reduce air emissions from shipping and measures addressing oil accidents and illegal oil discharges agreed in this Action Plan will contribute to the decreased concentration of nutrients and hazardous substances in sea water; the actions to prevent introduction of invasive and alien species via shipping will be crucial for achievement of thriving and balanced communities of plants and animals.

To measure progress towards the management objectives, the set of indicators as on page 84 will be used.

Enforcement of international regulations – No illegal discharges

WE CALL UPON all Baltic Sea States to ratify and implement IMO conventions, and to this end

WE WELCOME WITH APPRECIATION that the 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships (the AFS Convention) will enter into force on 17 September 2008,

WE AGREE that all HELCOM Contracting States shall by 2008-2009 ratify the AFS Convention,

WE ALSO AGREE that as of 1 January 2010 no ships calling at a port in the Baltic Sea area may use organotin compounds which act as biocides in its antifouling system having in mind that this requirement is applicable to ports of EU member states already from 1 January 2008 and to ports of the Contracting Parties to the AFS Convention according to its Article 18,

WE ALSO AGREE to promote development of effective, environmentally friendly and safe TBT-free antifouling systems on ships,

WE ALSO AGREE that HELCOM should play a proactive role concerning the effective enforcement of the AFS Convention in the Baltic Sea area by developing a monitoring system enabling the detection of non-compliant ships entering the HELCOM area. Such a system should be based on the list possibly to be developed and updated in co-operation with the 1982 Paris Memorandum of Understanding on Port State Control (the 1982 Paris MoU) and make use of the HELCOM Automatic Identification System (HELCOM AIS),

FURTHERMORE WE AGREE that all Contracting States will ratify Annex VI to the 1973 International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), not later than 1 January 2010,

WE DECIDE in co-operation with the European Maritime Safety Agency to make full use of the satellite images made available to the Baltic Sea States and to establish harmonised satellite and aerial surveillance covering the whole Baltic Sea area to improve detection of illegal oil spills in the Baltic,

WE ENCOURAGE projects by local governments and local communities to remove litter from the coastal and marine environment, such as beach clean-up operations, “Fishing for Litter” initiatives and local litter campaigns, noting the leading role of the voluntary sector in such activities,

WE AGREE to extend the “no-special-fee” system for ship-generated wastes in the Baltic Sea region to cover also wastes caught in fishing nets and to consider adequate incentives to encourage delivery by fishermen of such waste to onshore port reception facilities. To this end **WE ADOPT** the revised HELCOM Recommendation 28/1 “Application of the “no-special-fee” system to ship-generated wastes in the Baltic Sea Area” as HELCOM RECOMMENDATION 28E/10 (page 59),

WE FURTHER AGREE to enhance the availability of adequate reception facilities for ship-generated wastes, mandatory delivery of waste and the application of the “no-special-fee” system in all the Baltic Sea ports,

WE ALSO AGREE to continue the enforcement of the existing legal regime e.g. through concentrated inspection campaigns under the 1982 Paris MoU and co-operation in prosecution of offenders of illegal discharges,

WE DECIDE to encourage development and use of innovative and cost-effective, integrated surveillance sensors permitting fast and reliable identification of pollutants on the sea surface and in the water column as well as emitted by ships to the air, e.g. light detection and ranging technologies,

WE STRESS the importance of the use of the HELCOM AIS system to ensure the effective enforcement of existing legal regimes, and **AGREE** to extend existing monitoring of non-compliant ships and of the movement of ships in the Baltic which have been detained under the 1982 Paris MoU with a view to giving strong support to port state controls especially of these ships.

Safe maritime traffic without accidental pollution

WE DECIDE to advance winter navigation safety and efficiency in the Baltic Sea and enhance the co-operation between all Baltic Sea States during wintertime by strengthening our co-operation with the maritime authorities from all Baltic Sea States within the framework of Baltic Icebreaking Management (BIM). To this end **WE ADOPT** HELCOM RECOMMENDATION 28E/11 “Further measures to improve the safety of navigation in ice conditions in the Baltic Sea” (page 63),

WE DECIDE to encourage shipping companies to use ships with crew trained for winter navigation and to use voluntary pilotage for winter navigation under ice conditions also in the open Northern Baltic Sea, including the Gulf of Finland, for enhanced navigation safety,

WE AGREE to consider having in 2008 a joint submission by the HELCOM Contracting States to IMO on the needed modification of AIS information content in order to optimise the opportunities provided by AIS and to further improve safety of navigation and protection of the environment,

WE ALSO AGREE to cooperate in the investigation of the potential for Differential Global Navigation Satellite System (DGNSS) broadcast via AIS base stations in the Baltic Sea, pending a recommendation from the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) on the subject,

WE AGREE to amend the HELCOM Agreement on Access to AIS Information by 2008 taking into account the proposal elaborated by HELCOM AIS EWG 16/2007,

WE DECIDE to support in IMO initiatives for introducing a general carriage requirement for Electronic Chart Display and Information System (ECDIS) as early as possible, and to request IMO to develop a concrete time schedule.

Efficient emergency and response capability

WE ADOPT HELCOM RECOMMENDATION 28E/12 “Strengthening of sub-regional co-operation in response field” (page 65),

WE AGREE to implement this Recommendation by 2013. To this end we **AGREE FURTHER**:

- by 2008 to develop and agree upon common methodology for the assessment of risk and sufficiency of emergency and response capacity, to be used with “Guidance for the sub-regional plans to quantify needed emergency/response resources” (page 66);
- by 2009 to finalise the assessments by the Contracting States of the risks of oil and chemical pollution and to finalise the quantification of the emergency and response resources at the sub-regional level (emergency towing, fire-fighting and emergency lightering, hardware,[*] human resources) needed to meet these risks;
- by 2010, based upon risk assessments, to identify the gaps in emergency and response resources at the sub-regional level and to prepare concrete plans/programmes for fulfilling them by 2013, except for emergency towing and response to accidents involving chemicals,

[*] *including but not limited to skimmer capacity, vessels, booms, storage capacity, adequacy of aerial and satellite surveillance to provide guidance to response operations*

for which the deadlines are 2013 and 2016, respectively; however this postponed timing should not refrain the Contracting States from earlier, if possible, implementation of the requirements;

- by 2010, based upon sensitivity mapping, to identify the need for and to finalise the quantification of countermeasures for shoreline response, and to prepare concrete plans/programmes for fulfilling them by 2013.

WE FURTHER AGREE to promote an efficient emergency management and efficient support for ships in need of assistance taking into account the specific needs of the Baltic Sea Region,

WE ALSO AGREE to encourage ships in need of assistance to accept in time the most appropriate response to a threat of pollution,

WE RECOGNISE the great importance of an efficient use of places of refuge and for that reason **DECIDE** to develop by 2009 and implement by 2010 a mutual plan for places of refuge in the Baltic Sea,

WE AGREE to further investigate issues of liability and compensation related to a mutual plan on places of refuge. This should include possible recovery of costs between different HELCOM Contracting States involved in a response action going beyond reimbursement schemes according to existing international conventions,

WE FURTHER AGREE on the need for a sufficient liability and compensation regime for damage in relation to carriage of hazardous and noxious substances by sea and to support ongoing work at the global level to put such a regime in place,

WE AGREE FURTHERMORE to make full use of satellite surveillance to assist response to accidental oil spills in the Baltic,

WE ALSO AGREE by 2009 to develop and agree on a decision support (approval) system for use of dispersants in the Baltic Sea setting the rules for dispersant application based on appropriate IMO Guidelines, Net Environmental Benefit Analyses (NEBA) and the existing knowledge of properties of oil transported in the Baltic,

WE FURTHER AGREE to promote development and to enhance the use of technology to respond to accidents at night and in bad visibility, in bad weather, oil on ice, accidents involving heavy oil, chemical accidents, and to continue the research work and information exchange to close gaps in the knowledge in this field,

WE AGREE to cooperate in order to develop best practices for shoreline response, to continue the research work and information exchange to close gaps in the knowledge in this field, in order to improve regional co-operation especially when introducing coastal planning and regional agreements on co-operation in response actions,

WE AGREE FINALLY to integrate the subject of oiled wildlife response into oil pollution contingency plans either on a national or sub-national/local level, as deemed appropriate by the relevant Contracting State.

Minimum sewage pollution from ships

WE AGREE to have in 2009 a joint submission by HELCOM Contracting States to IMO in order to elaborate relevant new regulations for ships covered by the existing Annex IV to MARPOL 73/78, including further consideration of designation of the Baltic Sea as a special area, with the aim to eliminate the discharge of sewage from ships, especially from passenger ships and ferries,

WE FURTHER AGREE to encourage voluntary activities in ports and shipping companies to dispose of sewage to the port reception facilities. To this end **WE AGREE** to undertake all the necessary improvements in the availability of these port reception facilities.

No introductions of alien species from ships

WE ADOPT the road map towards ratification and harmonised implementation of the 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments (BWM Convention) as contained on page 97,

WE AGREE in 2008, in co-operation with the OSPAR Convention, to investigate and if possible determine areas outside the Baltic Sea area for Ballast Water Exchange,

WE FURTHER AGREE THAT the ultimate goal of implementing the road map is ratification of the BWM Convention by the HELCOM Contracting States preferably by 2010, but in all cases not later than 2013.

Minimum air pollution from ships

WE AGREE by 2009 to investigate and when appropriate take into consideration introduction of feasible and effective economic incentives in the Baltic Sea for reducing emissions by ships. To this end **WE ADOPT** HELCOM RECOMMENDATION 28E/13 "Introduction of economic incentives as a complement to existing regulations to reduce emissions from ships" (page 68).

WE AKNOWLEDGE the serious impact on the particularly sensitive Baltic Sea ecosystem from regional, and due to the transboundary character of air emissions, also global shipping activities. Therefore, **WE AGREE** to support efforts within IMO under the ongoing review process of Annex VI of MARPOL 73/78 to tighten sulphur content in fuel oil at the global level, by having a joint submission to IMO as contained on page 99 by 25 January 2008 prior to MEPC 57 in April 2008, with the aim of addressing also the regional component of the issue,

WE AGREE to contribute to the work by IMO aiming at implementing more stringent requirements for emissions from shipping by evaluating the impact of NOx emissions from shipping in the Baltic on the marine environment of the Baltic Sea. To this end **WE AGREE**:

- to have in 2008 a joint submission by the HELCOM Contracting States to IMO evaluating the environmental effect on the Baltic Sea of possible new NOx emission control measures,
- to further estimate the contribution of NOx emissions from shipping to eutrophication of the Baltic Sea to encourage revision of Annex VI of MARPOL 73/78.

Zero-discharge from offshore platforms

WE AGREE on the Action Plan for the protection of the environment from offshore platforms to apply a "zero-discharge" principle for the offshore platforms in the Baltic Sea starting from 1 January 2010, as contained on page 100.

Minimum threats from offshore installations

HAVING IN MIND that the Baltic Sea faces an increasing number of – in many cases - competing uses and that the installations such as underwater cables, pipelines and offshore wind farms put increasing pressure on the Baltic Sea ecosystem, **WE AGREE** that HELCOM Contracting Parties will carefully follow the relevant processes with the understanding that any environmentally significant adverse impacts on the environment that may be caused by any offshore installation should be prevented, reduced or offset as fully as possible.

Development of assessment tools and methodologies

Development of assessment tools and methodologies

WE ADOPT HELCOM RECOMMENDATION 28E/14 on harmonisation of methods to assess diffuse nutrient loads from the Baltic Sea catchment area to enable more reliable estimation and assessment of nutrient load from agriculture and other diffuse sources and to ultimately combine and develop joint catchment models covering the whole Baltic Sea area and linking the nutrient input with ecosystem modelling on the effects in the marine environment (page 73),

WE ACKNOWLEDGE that the HELCOM Baltic Sea Action Plan requires a harmonised approach to assess the eutrophication status of the Baltic Sea. Therefore **WE AGREE** to further develop the common HELCOM eutrophication assessment tool, by promoting inter alia the HELCOM Project to elaborate the HELCOM Baltic Sea-wide thematic assessment on eutrophication (HELCOM EUTRO-PRO) taking into account the Common Implementation Strategy (CIS) Guidance document on eutrophication assessment made in the context of European water policies,

WE ACKNOWLEDGE that the HELCOM Baltic Sea Action Plan requires efficient use of analytical tools, such as models, to support management decisions, that development and use of ecosystem models need efficient co-operation and optimisation due to limited resources available in the scientific community and that scientific consensus on the model approach is important for the acceptance of the results by management,

WE ENCOURAGE efforts to institutionalise and make operational the relevant modelling activities and to prioritise information delivery to HELCOM, bearing in mind that modelling needs to be seen as a long-term activity that extends beyond individual scientists and projects,

Therefore, **WE AGREE** to further develop information provision from ecosystem models and to co-operate closely in doing so, bearing in mind the requirements of the HELCOM Baltic Sea Action Plan in developing targets for good ecological status, indicators for assessing the ecological status of the marine environment and in estimating future allowable nutrient inputs to the Baltic Sea and its sub-regions without jeopardising achievement of the good ecological and environmental status,

WE ACKNOWLEDGE that the HELCOM Baltic Sea Action Plan requires an integrated assessment of the occurrence and inputs, as well as uses and sources, of hazardous substances in the Baltic Sea region. Therefore, **WE STRESS** the importance of a Baltic Sea-wide thematic assessment on hazardous substances to be ready by 2010,

WE ACKNOWLEDGE that the HELCOM Baltic Sea Action Plan requires a harmonised approach to assess the conservation status of biodiversity and nature protection of the Baltic Sea. Therefore, **WE AGREE** to further develop the common HELCOM approach and assessment tools for these purposes.

By doing so, **WE WELCOME** the HELCOM Project to elaborate the HELCOM Baltic Sea-wide thematic assessment on biodiversity and nature protection (HELCOM BIO) defining indicators and targets for the favourable conservation status of Baltic Sea biodiversity and ecological coherence of the Baltic Sea Protected Areas network,

WE AGREE to continuously monitor the conservation status of biodiversity and the effectiveness of nature protection measures and periodically evaluate whether the targets of this Action Plan have been met using indicator-based assessments,

WE ALSO ACKNOWLEDGE that the HELCOM Baltic Sea Action Plan requires an integrated assessment of the inputs of pollution from shipping and their effect on the Baltic Sea environment. Therefore, **WE STRESS** the importance of a Baltic Sea-wide thematic assessment on maritime shipping to be ready by 2010.

Awareness raising and capacity building

Awareness raising and capacity building

WE ACKNOWLEDGE that public engagement and stakeholder involvement can effectively contribute to a successful implementation of the Baltic Sea Action Plan and therefore **RECOMMEND** countries, regional and local government and organizations representing civil society to engage the public and stakeholders in activities promoting a healthy Baltic Sea and to actively promote public participation in decision making.

WE STRESS the importance of raising the awareness of the public regarding the effects on human health and the environment of hazardous substances. To this end **WE AGREE** that by 2008 the Contracting Parties should develop and inform HELCOM about their regular information campaigns,

WE STRESS the importance of further capacity building within and between authorities as well as for industries on the identification and implementation of requirements concerning hazardous substances,

WE FURTHER DECIDE to implement a public awareness programme aimed at involving the public in the detection of illegal discharges from ships,

WE AGREE on raising public awareness of the negative environmental and economic effects of marine litter in the marine environment, including effects of "ghost fishing" of lost or discarded fishing gear,

WE FURTHER DECIDE to implement an awareness programme regarding the importance of the proper fulfilment of existing international regulations concerning ship-generated waste discharges including on-shore disposal and treatment of all ship-generated sewage,

WE ALSO AGREE to promote environmentally friendly pleasure boating and the development of marinas and the use of the best ecological practice by every marina/guest harbour, including education and raising awareness of the personnel and boat owners of key marinas/guest harbours,

WE DECIDE to expand the HELCOM Geographic Information System with an interface on the HELCOM website showing the progress towards a healthy Baltic Sea.

Financing

Financing

WE AGREE that a cost benefit analysis of projects, including the cost of non-action and unit abatement cost (UAC) calculation, should be the basis when deciding on implementation taking into account NEFCO's findings that

- all projects with a UAC for reduction of phosphorus that is below € 150,000 per tonne reduced are examples of cost-efficient actions and should be implemented as soon as possible;
- based on current information the nutrient reduction needs indicated by HELCOM to meet the objectives for eutrophication would be met if all these cost-efficient investments were implemented together with relevant EU Directives,
- particularly cost-efficient projects for phosphorus reduction are
  - proper manure management at large animal installations;
  - addition of chemical phosphorus treatment in existing waste water treatment plants;
  - construction and upgrading of wastewater systems in larger and smaller cities/municipalities;
  - reduction/substitution of phosphorus in detergents,

WE STRESS THE NEED for using adequate and comprehensive financial resources for environmental investments for actions according to the Baltic Sea Action Plan in particular within the new EU countries e.g. through sector programmes. The main sources of funding are state budgets and EU's structural funds including the Cohesion Fund, which are made available to the new EU Member States also for implementation relevant EU directives;

WE ALSO FIND that non-EU Member States can benefit from financing in the context of the EU Neighbourhood and Partnership Instruments,

WE ENCOURAGE Contracting Parties that are EU Member States as well as regional and local governments and others concerned to identify projects and apply for financing through e.g. the objective "Territorial Co-operation" under the EU Regional Fund or the Cohesion Fund.

WE ALSO ENCOURAGE Contracting Parties to take additionally into account bilateral sources as well as the European Neighbourhood and Partnership Initiative (ENPI) and Northern Dimension Environmental Partnership (NDEP) which are offering grant financing for high priority environmental projects in Russia.

For this reason **WE AGREE** that all Contracting Parties shall investigate how to make better use of available funding for the financing of the implementation of the HELCOM Baltic Sea Action Plan, taking especially into account the need to connect priorities within the different sectors in which projects are being chosen for financing, and the need during this process to make use of transparent parameters, such as unit abatement cost,

WE ALSO WELCOME the growing interest of private companies and non-profit foundations to provide funds for the protection of the Baltic Sea on a voluntary basis,

WE AGREE to start in 2008 to identify and list projects based on e.g. results of the Fifth Pollution Load Compilation (PLC-5) and document "Background paper on financing and cost-efficiency" elaborated by NEFCO with a UAC for reduction of phosphorus below € 150,000 per tonne which could be addressed by initiating joint initiatives in the Baltic Sea catchment area in co-operation with non-profit foundations and private companies.

In order to overcome bottlenecks in already approved projects and in the development of new ones, and to speed up and increase investments within municipal infrastructure for wastewater treatment and within the agricultural sector, including environmental investments in large animal farms, **WE RECOMMEND** the following actions:

- providing adequate resources for training for project preparation and implementation
- providing additional support for training and advice for farmers
- training of central and regional environmental authorities for proactivity in project development and support to applicants
- conducting information seminars for commercial banks regarding unit abatement cost calculations in environmental projects
- increased focus on the dialogue with Russia concerning institutional development in particular with a view to creating a higher number of bankable projects within municipal infrastructure such as water supply and wastewater treatment, food industry such as large animal farms, and other industry for cleaner production processes.

To urgently start the actions required to enhance investments to achieve the goals of the HELCOM Baltic Sea Action Plan , **WE AGREE** to arrange a "pledging conference" **-** this time pledging not only monetary resources, but also pledging to give priority to solving the above-mentioned bottlenecks through concrete actions, within an agreed time frame and thus trying to ensure that projects within the environmental sector, rather than other sectors with larger and less complicated project structures, will be given priority in the final project selection stage.

Implementation and review of the HELCOM Baltic Sea Action Plan

Implementation and review of the HELCOM Baltic Sea Action Plan

WE AGREE to monitor and evaluate the status of implementation of the Baltic Sea Action Plan by making use of the indicators agreed upon as well as HELCOM thematic assessments, annual HELCOM indicator fact sheets and other information available,

WE DECIDE to arrange in 2013 a HELCOM ministerial meeting to evaluate the effectiveness of the national programmes and to review the progress towards the ecological objectives describing a Baltic Sea in good ecological status. Based on this review the Action Plan will be adjusted and the set of indicators with associated targets will be up-dated to ensure their relevance for achieving the objectives.

Given the political priority of the HELCOM Baltic Sea Action Plan, **WE AGREE** on the need for a Baltic Sea Action Plan implementation process steered on a high level and thus

WE DECIDE to establish a Baltic Sea Action Plan Implementation Group and to decide on its Terms of Reference at HELCOM 29/2008.

The implementation process needs to build on close co-operation amongst all present and future HELCOM bodies and may possibly require the adjustment of the HELCOM working structure.

Recommendations

Recommendations

HELCOM RECOMMENDATION 28E/4

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 c)
of the Helsinki Convention

AMENDMENTS TO ANNEX III "CRITERIA AND MEASURES CONCERNING THE PREVENTION OF POLLUTION FROM LAND-BASED SOURCES" OF THE 1992 HELSINKI CONVENTION

THE COMMISSION,

TAKING INTO CONSIDERATION the amendment procedure for the Annexes of the 1992 Helsinki Convention, as contained in Article 32 of that Convention,

RESOLVES:

a) to amend Annex III of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992, in accordance with the Attachment to this Recommendation;

b) to ask the Depositary Government to Communicate these amendments to the Contracting Parties with the Commission's Recommendation for acceptance; and

c) to determine that the accepted amendments shall enter into force one year after the adoption of this HELCOM Recommendation,

REQUESTS the Governments of the Contracting Parties to report on the progress of implementation of the amendments to Annex III in accordance with the agreed deadlines and Article 16, Paragraph 1 of the 1992 Helsinki Convention.

Attachment

Revised Annex III "Criteria and Measures Concerning the Prevention of Pollution from Land-Based Sources"

Part II: Prevention of Pollution from Agriculture

Regulation 1: General provisions

In accordance with the relevant parts of this Convention, the Contracting Parties shall apply the measures described below and take into account Best Environmental Practice (BEP) and Best Available Technology (BAT) to reduce the pollution from agricultural activities. The Contracting Parties shall elaborate Guidelines containing items specified below and report to the Commission.

Regulation 2: Plant nutrients

The Contracting Parties shall integrate the following basic principles into national legislation or guidelines and adapt them to the prevailing conditions within the country to reduce the adverse environmental effects of agriculture. Specified requirement levels shall be considered to be a minimum basis for national legislation.

1. Animal density

To ensure that manure is not produced in excess in comparison to the amount of arable land, there must be a balance between the number of animals on the farm and the amount of land available for spreading manure, expressed as animal density. The maximum number of animals should be determined with consideration taken of the need to balance between the amount of phosphorus and nitrogen in manure and the crops' requirements for plant nutrients.

2. Location and design of farm animal houses

Farm animal houses and similar enclosures for animals should be located and designed in such a way that ground and surface water will not be polluted.

3. Construction of manure storage

Manure storage must be of such a quality that prevents losses. The storage capacity shall be sufficiently large to ensure that manure only will be spread when the plants can utilise nutrients. The minimum level to be required should be 6 months' storage capacity.

Manure storage should be constructed to safeguard against unintentional spillages and be of such a quality that prevents losses. With regard to different types of manure, the following principles should be considered:

- solid manure should be stored in dung yards with watertight floor and side walls
- liquid manure and farm waste should be stored in containers that are made of strong material impermeable to moisture and resistant to impacts of manure handling operations.

Animal manure should be used in such a way that as high a utilisation efficiency as possible is promoted.

Co-operation between farmers in the use of manure has to be encouraged.

5. Agricultural wastewater, manure and silage effluents

Wastewater from animal housing should either be stored in urine or slurry stores or else be treated in some suitable manner to prevent pollution. Effluents from manure or from preparation and storage of silage should be collected and directed to storage units for urine or liquid manure.

6. Application of organic manures

Organic manures (slurry, solid manure, urine, sewage sludge, composts, etc) should be used in such a way that a high utilisation efficiency can be achieved. Organic manures shall be spread in a way that minimises the risk of loss of plant nutrients and should not be spread on soils that are frozen, water saturated or covered with snow. Organic manures should be incorporated as soon as possible after application on bare soils. Periods shall be defined when no application is accepted.

7. Application rates for nutrients

The application of nutrients in agricultural land shall be limited, based on a balance between the foreseeable nutrient requirements of the crops and the nutrient supply to the crops from the soil and the nutrients with a view to minimise eutrophication.

National guidelines should be developed with fertilising recommendations and they should make reference to:

- soil conditions, soil nutrient content, soil type and slope;
- climatic conditions and irrigation;
- land use and agricultural practices, including crop rotation systems;
- all external potential nutrient sources

The amount of livestock manure applied to the land each year including by the animals themselves should not exceed the amount of manure containing:

- 170 kg/ha nitrogen
- 25 kg/ha phosphorus

with a view to avoiding nutrient surplus, taking soil characteristics, agricultural practices and crop types into account.

8. Winter crop cover

In relevant regions the cultivated area should be sufficiently covered by crops in winter and autumn to effectively reduce the loss of plant nutrients

9. Water protection measures and nutrient reduction areas

Protection measures should be established to prevent nutrient losses to water particularly as regards

- Surface water: buffer zones, riparian zones or sedimentation ponds should be established, if necessary.
- Groundwater: Groundwater protection zones should be established if necessary. Appropriate measures such as reduced fertilisation rates, zones where manure spreading is prohibited and permanent grassland areas should be established.
- Nutrient reduction areas: Wetland areas should be retained and where possible restored, to be able to reduce plant nutrient losses and to retain biological diversity.

10. Ammonia emissions

In order to reduce ammonia emissions from animal husbandry, a surplus of nitrogen in the manure should be avoided by adjusting the composition of the diet to the requirements of the individual animal. In poultry production, emissions should be brought down by reducing the moisture content of the manure or by removal of manure to storage outside the housing system as soon as possible.

Programmes including strategies and measures for reducing ammonia volatilisation from animal husbandry should be developed.

Urine and slurry stores should be covered or handled by a method that efficiently reduces ammonia emissions.

Regulation 3: Plant protection products

Plant protection products shall only be handled and used according to a national risk reduction strategy which shall be based on BEP. The strategy should be based on an inventory of the existing problems and define suitable goals. It shall include measures such as:

1. Registration and approval

Plant protection products shall not be sold, imported or applied until registration and approval for such purposes has been granted by the national authorities.

2. Storage and handling

Storage and handling of plant protection products shall be carried out so that the risks of spillage or leakage are prevented. Some crucial areas are transportation and filling and cleaning of equipment. Other dispersal of plant protection products outside the treated agricultural land area shall be prevented. Waste of plant protection products shall be disposed of according to national legislation.

3. Licence

A licence shall be required for commercial use of plant protection products. To obtain a licence, suitable education and training on how to handle plant protection products with a minimum of impact on health and the environment shall be required. The users' knowledge regarding the handling and usage of plant protection products shall be updated regularly.

4. Application technology

Application technology and practice should be designed to prevent unintentional drift or runoff of plant protection products. Establishment of protection zones along surface waters should be encouraged. Application by aircraft shall be forbidden; exceptional cases require authorisation.

5. Testing of spraying equipment

Testing of spraying equipment at regular intervals shall be promoted to ensure a reliable result when spraying with plant protection products.

6. Alternative methods of control

Development of alternative methods for plant protection control should be encouraged.

Regulation 4: Environmental permits

Farms with livestock production above a specified size should require approval with regard to environmental aspects and impacts of the farms.

Installations for the intensive rearing of poultry, pigs and cattle with more than 40,000 places for poultry, 2,000 places for production pigs (over 30 kg), 750 places for sows or 400 animal units cattle shall have a permit fully co-ordinated by the relevant authorities.

The permits must take into account the whole environmental performance of the enterprise, covering e.g. emissions to air, water and land, generation of waste and prevention of environmental accidents. The permit conditions must be based on BAT.

The competent authorities, in determining permit conditions, can take into account the technical characteristics of the enterprise, its geographical location and the local environmental conditions.

These large animal enterprises shall be considered as point sources and shall have adequate measures.

For installations with more than 100 AU the Contracting Parties shall put in practice general rules or a system corresponding to a simplified permit system to ensure the implementation of the requirements in this Annex.

Both of these permit systems shall be applied to existing installations and new installations and existing installations which are subject to substantial changes by 2012.

Regulation 5: Monitoring and evaluation

The Contracting Parties shall describe the implementation and monitoring of measures in this Annex in their national programmes.

To evaluate the effectiveness of the measures, the Contracting Parties shall develop projects to assess the effects of measures and the impacts of the agricultural sector on the environment.

Regulation 6: Education, information and extension service

The Contracting Parties shall promote systems for education, information and extension (advisory service) on environmental issues in the agricultural sector.

HELCOM RECOMMENDATION 28E/5

Supersedes HELCOM Recommendations 7/3, 9/2 and 16/9

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

MUNICIPAL WASTEWATER TREATMENT

THE COMMISSION,

RECALLING Paragraph 1 of Article 6 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the Baltic Sea Area from land-based sources,

HAVING REGARD also to Article 3 of the Helsinki Convention, in which the Contracting Parties shall individually or jointly take all appropriate legislative, administrative or other relevant measures to prevent and abate pollution in order to promote the ecological restoration of the Baltic Sea Area,

RECALLING Article 5 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the marine environment of the Baltic Sea caused by harmful substances,

RECALLING FURTHER that the Ministerial Declaration 1988, of the ninth meeting of the Helsinki Commission calls for a considerable reduction of land-based pollution,

RECALLING FURTHER Recommendation 9/2 from 1988 concerning measures aimed at the reduction of discharges from urban areas by the use of effective methods in wastewater treatment requiring phosphorus reduction for plants serving more than 10 000 p.e. down to 1.5 mg P/l,

RECALLING FURTHER the outcome of the informal Ministerial Meeting 2005 and the 27th meeting of the Helsinki Commission which call for further action regarding the Baltic Sea by deciding to elaborate a Baltic Sea Action Plan (BSAP),

RECALLING FURTHER the Ministerial Meeting 2007 in which the Ministers adopted the Baltic Sea Action Plan (BSAP) which calls for urgent actions to reduce the discharges of nutrients to the Baltic Sea Area,

RECOGNISING ALSO that in an urban area the sewerage system and the sewage treatment plant must be regarded as a unit when the pollution load is dealt with. For practical reasons, however, this Recommendation covers only the treatment of the amounts of water entering the sewage treatment plant. Concerning the pollution load due to sewer overflows, this is regulated in a qualitative manner in Recommendation 7/5, e). Work is ongoing to strengthen this by stating specific values,

RECOGNISING ALSO the need for development of the present sewerage systems,

RECOGNISING the importance of municipal sewage as a source of pollution of the marine environment,

RECOGNISING ALSO that improved phosphorus removal has been found to be necessary in the Baltic Sea Area,

RECOGNISING ALSO that phosphorus from medium-sized Urban Waste Water Treatment Plants is contributing to the eutrophication of the Baltic Sea,

RECOGNISING ALSO that nitrogen removal has been found to be necessary in many parts of the Baltic Sea Area,

DESIRING to limit this pollution by effective treatment of municipal sewage,

RECOMMENDS to the Governments of the Contracting States to the Helsinki Convention that:

A. Development of sewerage systems

1. Urban (municipal) wastewater deriving from households (domestic wastewater) or industrial enterprises should be collected and treated before being discharged into waterbodies; by-passes may only be used in emergency cases;

2. The sewerage system must not become deteriorated due to the content of substances in the effluent water from industries,

3. A separated sewerage system and/or a semi-separated sewerage system should be selected for new developments;

4. Sewers should be maintained and renewed in a way that infiltration and exfiltration are minimised;

5. The net infiltration in major catchment areas should not exceed 100% of the dry weather flow as a yearly average.

B. Treatment of municipal wastewaters discharging to the catchment of the Baltic Sea area.

1. Limit values for substances harmful to the receiving waters which cannot be treated in the municipal wastewater treatment plants or which are harmful to the sewerage systems or the processes of the treatment plant should be established separately for industry and other relevant sectors discharging indirectly based on the BAT and BEP.

2. Domestic sewage or wastewater of similar type which is collected in a central sewerage system and treated in wastewater treatment plants, with a load of 300 - 2 000 person equivalents, should be treated so that the treatment results in:

- at least 80% reduction of BOD_5, or 25 mg/l
- at least 70% reduction of total phosphorus, or 2 mg/l, when discharging directly or indirectly to the marine areas
- at least 30% reduction of total nitrogen, or 35 mg/l, when discharging directly or indirectly to marine areas sensitive to nitrogen.

Alternatively, reduction requirements as set out in HELCOM RECOMMENDATION 28E/6 on on-site wastewater treatment of single family homes, small businesses and settlements up to 300 person equivalents (p.e.) must be applied.

3. Domestic sewage or wastewater of similar type which is collected in a central sewerage system and treated in wastewater treatment plants, with a load of **2,000 – 10,000 person equivalents**, should be treated so that the treatment results in:

- at least 80% reduction[*] of BOD_5[**]; or at most a concentration of BOD_5 in the effluent of the treatment plant of 15 mg/l.
- at least 80% reduction of total phosphorus; or at most a concentration of total phosphorus in the effluent of the treatment plant of 1[***] mg/l when discharging directly or indirectly to the marine areas;

[*] *In this recommendation: the relation to the load of the influent*
[**] *Calculated as annual means with nitrification inhibitor*
[***] *Target value, calculated as annual means.*

- at least 30% reduction of total nitrogen****, when discharging directly or indirectly to marine areas sensitive to nitrogen.

4. Domestic sewage or wastewater of similar type which is collected in a central sewerage system and treated in wastewater treatment plants, with a load of **10,001 – 100,000 person equivalents**, should be treated as soon as possible so that the treatment results in:

- at least 80% reduction of BOD_5; or at most a concentration of BOD_5 in the effluent of the treatment plant of 15 mg/l.
- at least 90% reduction of total phosphorus; or at most a concentration of total phosphorus in the effluent of the treatment plant of 0.5***** mg/l when discharging directly or indirectly to the marine areas;
- a minimum of 70-80% reduction of total nitrogen; or at most a concentration of total nitrogen in the effluent of the treatment plant of 15 mg/l, when discharging directly or indirectly to marine areas sensitive to nitrogen.

5. Domestic sewage or wastewater of similar type which is collected in a central sewerage system and treated in wastewater treatment plants, with a load of **more than 100,000 person equivalents**, should be treated as soon as possible so that the treatment results in:

- at least 80% reduction of BOD_5; or at most a concentration of BOD_5 in the effluent of the treatment plant of 15 mg/l.
- at least 90% reduction of total phosphorus; or at most a concentration of total phosphorus in the effluent of the treatment plant of 0,5 mg/l when discharging directly or indirectly to the marine areas
- a minimum of 70-80% reduction of total nitrogen; or at most a concentration of total nitrogen in the effluent of the treatment plant of 10****** mg/l, when discharging directly or indirectly to marine areas sensitive to nitrogen.

6. Alternatively, the requirements for individual plants set out in paragraphs 1, 2, 3, 4 and 5 need not apply where it can be shown that the minimum percentage of reduction of the overall load entering all urban wastewater treatment plants in the catchment area is at least 90% for total phosphorus when discharging directly or indirectly to the marine areas and 75% for total nitrogen for plants discharging directly or indirectly to marine areas sensitive to nitrogen.

7. The Contracting States shall ensure that urban wastewater entering collecting systems before discharge fulfil the demands stated in paragraphs 2, 3, 4 and 5 according to the following timetable, without prejudice to existing legislation applicable to Contracting States that are also EU Members

- at the latest by 31 December 2010 for discharges from agglomerations of more than 200,000 p.e.,
- at the latest by 31 December 2012 for discharges from agglomerations of more than 100,000 p.e.,
- at the latest by 31 December 2015 for discharges from agglomerations of between 10,000 and 100,000 p.e.,
- at the latest by 31 December 2018 for discharges from agglomerations of between 2,000 and 10,000 p.e.,

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**** *Total nitrogen means the sum of total Kjeldahl nitrogen (organic + NH_4), nitrate (NO_3)-nitrogen and nitrite (NO_2)-nitrogen.*

***** *The concentration values in Recommendation are Target values, calculated as annual means.*

****** *Calculated as annual means. However, the requirements for nitrogen may be checked using daily averages when it is proved that the same level of protection is obtained. In this case, the daily average must not exceed 20 mg/l of total nitrogen for all the samples when the temperature from the effluent in the biological reactor is higher than or equal to 12 °C. The conditions concerning temperature could be replaced by a limitation on the time of operation to take account of regional climatic conditions.*

- at the latest by 31 December 2018 for discharges from agglomerations of between 300 and 2,000 p.e.,

Alternatively, for agglomerations above 10,000 p.e. the recommendation for phosphorus treatment in the wastewater would be 1.0 mg/l or 90% reduction until 2013.

The implementation of the 0.5 mg/l requirement will be decided by the Contracting States according to national programmes to HELCOM by 2010.

RECOMMENDS FURTHER that the Contracting States report to the Helsinki Commission every three years starting at the end of 2010 with data from 2009,

RECOMMENDS ALSO that the Contracting Parties re-evaluate the present Recommendation and reconsider it in 2015 taking into account new developments on national or international and EU level for Member States,

RECOMMENDS ALSO that the Contracting Parties establish a programme for the implementation of this Recommendation and that the Contracting Parties provide the Helsinki Commission with information on the programme at the latest by 31 December 2009.

REPORTING FORMAT FOR HELCOM RECOMMENDATION 28E/5 CONCERNING MUNICIPAL WASTEWATER TREATMENT				
Lead Country: Sweden				
Country:				Year:
A. Development of municipal sewerage networks				
1. What type of sewerage system is:	Combined		Semi-separated	Separated
a) in use (percentage of length for each type, or rank 1,2,3)?				
b) chosen for new developments (percentage for each type or rank)?				
2. To what extent are sewers being renovated (e.g. km/year, certain areas etc.)				
3. Is renovation of networks a matter for the central, regional or local governments?				
4 a. Have assessments been made of the net infiltration into sewerage systems in major catchment areas?	Yes		No	Unknown
4 b. If so, do the results show compliance with the recommended max 100% infiltration of baseflow rates?	Yes		No	Partly
B. Treatment of municipal wastewater treatment				
1. Are there any limit values or target values for different substances permitted into the sewerage and/or to the wastewater treatment plants? If yes, please submit them (or in case of earlier Submission, give reference to the earlier document)				
2. Number of persons (million inhabitants) and percentage of population connected to municipal wastewater treatment				
3. For the different size classes give the number of plants and the number of persons served:				
	101 – 2,000 p.e.	2001 – 10,000 p.e.	10,001 – 100,000 p.e.	> 100,000 p.e.
a) at the coast of the Baltic Sea				
b) within the catchment area of the Baltic Sea				
c) located in nitrogen-sensitive areas				
d) located in nitrogen-sensitive areas and in compliance with nitrogen removal requirements				
e) in compliance with phosphorus removal requirements				
f) in compliance with BOD removal requirements				

4. Different treatment methods, per cent of population served:		
	Total discharges to the Baltic catchment area	Direct discharges to the Baltic Sea
a) no treatment		
b) mechanical		
c) biological		
d) chemical		
e) biological-chemical		
f) other methods		
5. Wastewater flow, million m^3/a		
6. Discharge to water of substances in **treated** wastewater, t/a		
a) $BOD_{5\ ATU}$		
b) phosphorus		
c) nitrogen		
7. Reduction, in per cent		
a) $BOD_{5\ ATU}$		
b) phosphorus		
c) nitrogen		
8. Discharge of wastewater of **untreated** wastewater (overflows and bypasses)		
a) volume, million m^3/a		
b) $BOD_{5\ ATU}$, t/a		
b) phosphorus, t/a		
c) nitrogen, t/a		
9. Describe how areas sensitive or non-sensitive to nitrogen have been assessed; methods or reference to publication.		
10. Describe how the Recommendation concerning municipal wastewater treatment has been implemented; new legislation, amendment to existing legislation or other means.		
11. Please submit a map of designated areas sensitive to nitrogen		

HELCOM RECOMMENDATION 28E/6

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

ON-SITE WASTEWATER TREATMENT OF SINGLE FAMILY HOMES, SMALL BUSINESSES AND SETTLEMENTS UP TO 300 PERSON EQUIVALENTS (P.E.)

THE COMMISSION,

RECALLING Paragraph 1 of Article 6 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the Baltic Sea Area from land-based sources by using, inter alia, Best Environmental Practice for all sources and Best Available Technology for point sources,

HAVING REGARD to Article 3 of the Helsinki Convention, in which the Contracting Parties shall individually or jointly take all appropriate legislative, administrative or the relevant measures to prevent and abate pollution in order to promote the ecological restoration of the Baltic Sea Area,

RECALLING the Ministerial Declaration of 1988 and the Baltic Sea Declaration of 1990, calling, inter alia, for a substantial reduction of the inputs caused by diffuse sources,

RECALLING FURTHER HELCOM Recommendation 9/2 in which the use of effective methods of wastewater treatment is stressed,

RECOGNISING the fact that a substantial part of the eutrophication problems observed in the Baltic Sea Area is caused by nutrient inputs from diffuse sources,

RECOGNISING that wastewater discharges originating from sources outside urban wastewater collection systems, such as single family homes, small businesses and settlements are a land-based source from which considerable quantities of nutrients are likely to reach, directly or indirectly, the marine area,

TAKING INTO ACCOUNT that stricter requirements for on-site wastewater treatment outside sewer networks are likely to enhance water quality also in local water bodies and shallow wells used for extraction of drinking water,

NOTING that for the purpose of this Recommendation the following definitions apply:

Grey water:	Non-industrial wastewater generated in domestic processes, excluding human excrements, such as washing dishes, laundry and bathing
Black water:	Domestic wastewater containing human excrements
Composting dry toilet:	A toilet system without water flush used for disposal of and biological processing of human excrement into organic compost material.

NOTING that the objective of this Recommendation is to reduce domestic and other wastewater discharges from sources outside urban wastewater collection systems,

NOTING FURTHER that this Recommendation covers those on-site wastewater systems which receive domestic or similar wastewater from single family homes, small businesses or settlements outside urban wastewater collection systems,

RECOMMENDS to the Governments of the Contracting States that the following practices should be promoted in on-site wastewater treatment for single family homes, small businesses and settlements up to 300 p.e.:

1. Untreated wastewaters shall not be led directly to natural water systems in areas that are not connected to sewers.

2. Wastewaters from single family homes, small businesses and settlements should be treated so that emissions per capita to the environment reach at most the values set in Table 1.

For a high standard household with warm water, showers, laundry and dishwashing machines and flush toilets this would mean approximately a basic reduction of 80% of BOD_5, 70% of total phosphorus and 29% of total nitrogen.

Table 1. Maximum permissible daily load per capita for biological oxygen demand over five days (BOD_5), total phosphorus (P_{tot}) and total nitrogen (N_{tot}) of the treated wastewater.

Load parameter	Permissible load of treated wastewater (g $person^{-1}$ d^{-1})*
BOD_5	8
P_{tot}	0.65
N_{tot}	10

*g $person^{-1}$ d^{-1} is grams per person per day

Alternative 1: the requirements based on emissions per capita need not apply where it can be shown that an on-site wastewater treatment plant results in at most a concentration of BOD_5 of 20 mg/l, P_{tot} 5 mg/l and N_{tot} 25 mg/l in the effluent of the treatment plant.

Alternative2: the requirements based on emissions per capita need not apply where it can be shown that an on-site wastewater treatment plant using the Best Available Technology (BAT) is installed and operated so that the treatment results in at most a concentration of BOD_5 of 40 mg/l and 150 mg/l COD in the effluent of the treatment plant.

Alternative 3:
Mapping
Improved treatment shall be introduced in areas where the quality of the waterbody is below the desired quality, when – and only when - it can shown that that the quality of the waterbody is poorer due to the influence of discharged wastewater.

Treatment
Improved wastewater treatment must be introduced when a house not connected to public sewer is situated in an area where the aforementioned conditions are present. The following table shows different levels of treatment, depending on the sensitivity of the waterbody:

Receiving water sensitivity	Treatment type	BOD_5 reduction (%)	Phosphorus reduction (%)	Nitrification (%)
Class 1	Enhanced OP treatment	95	90	90
Class 2	Enhanced O treatment	95		90
Class 3	OP treatment	90	90	
Class 4	O treatment	90		

O: organic matter
P: phosphorus. (P-reduction achieved in effluent)
Nitrification: chemical process transforming ammonium-nitrogen (NH4-N) into nitrate (NO3-N).

3. The two possible phases of minimisation of the discharges of wastewater to the environment are

- the use of. dry toilets, phosphate-free detergents and minimisation of water consumption;

- Treatment of wastewater. The level of the treatment depends on the composition of the wastewater; black water needs a higher level of treatment than grey water.

Examples of wastewater generation and treatment options:

- Composting dry toilet with separation of urine in combination with on-site grey water treatment.
- Composting dry toilet in combination with on-site grey water treatment.
- Separation of grey water and black water, on-site treatment of grey water in combination with storage and transportation of black water to the municipal wastewater treatment plant for treatment.
- An on-site wastewater treatment system for all wastewaters.
- An on-site holding tank or cesspool with transportation to and treatment of wastewaters at a municipal wastewater treatment plant.

Drainage and storm waters should never be led to a wastewater treatment system.

For estimates of needed reduction levels for two different combinations of wastewater generation and treatment, see attachment.

4. Attention should be paid to reducing sludge formation and to promoting systems which enable recycling of nutrients back to agricultural use. Sludge should be collected, stored and transported to a municipal wastewater treatment plant or a designated sludge handling unit in manner that avoids leakages. Sludge from septic tanks or activated sludge systems should not be dumped into waterbodies or close to them.

5. A transitional period of 10 years for the households (with water flush toilets and 14 years without water flush toilets) to implement the Recommendation from the date of adoption should be applied,

RECOMMENDS FURTHER that the Contracting Parties report on the implementation of the Recommendation to the Commission, based on reporting requirements developed by the Land-based Pollution Group.

HELCOM RECOMMENDATION 28E/7

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

MEASURES AIMED AT THE SUBSTITUTION OF POLYPHOSPHATES (PHOSPHORUS) IN DETERGENTS

THE COMMISSION,

RECALLING Article 5 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the Baltic Sea Area caused by harmful substances from all sources, according to the provisions of this Convention and, to this end, to implement the procedures and measures of Annex I,

RECALLING ALSO that Annex I of the 1992 Helsinki Convention defines phosphorus as a harmful substance for the purposes of Article 5 of the Convention,

RECALLING FURTHER the Ministerial Communiqué 1998, calling for implementation of HELCOM Recommendation 19/5 on the HELCOM Objective with regard to Hazardous Substances, which is to prevent pollution of the Convention Area by continuously reducing discharges, emissions and losses of hazardous substances, with the ultimate aim of concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances, until 2020,

FURTHER RECALLING that based on HELCOM monitoring and assessment work on the state of the Baltic marine environment four strategic goals, reflecting the jointly identified major environmental problems in the Baltic Sea, have been adopted describing the desired state of the marine environment, namely a “Baltic sea unaffected by eutrophication”, “Baltic Sea life undisturbed by hazardous substances”, “Maritime activities carried out in an environmentally friendly way”, all of which will lead to a “Favourable status of Baltic Sea biodiversity”;

RECOGNISING the relative importance of detergents containing phosphates as a source of pollution by phosphorus, and the fact that phosphate-free detergents are available,

RECOGNISING FURTHER that sewage treatment investments are needed in parallel to the reduction of phosphates in detergents due to the need for the reduction of other polluting substances and other sources,

BEING MINDFUL of the pollution caused by discharges of phosphorus resulting from detergents containing phosphates which contribute to eutrophication, and the usefulness of taking adequate action on a flexible basis,

RECOMMENDS to the Governments of the Contracting States to the Helsinki Convention that:

a) Polyphosphates as builders in laundry detergents for consumer use should be substituted according to national programmes and measures with a timetable to be presented and decided at the HELCOM Ministerial Meeting in 2010. In practical terms, a maximum limit for the content of total phosphorus should be applied and a hurdle of 0.2 to 0.5% P weight/weight could be recommended;
b) possibilities for the substitution of the use of polyphosphates as builders in dishwasher detergents for consumer use be further investigated;
c) further investigations on alternative builders, especially on their use and environmental effects, be carried out.

RECOMMENDS FURTHER that the action taken by Contracting Parties in accordance with this Recommendation should be reported to the Commission annually,

DECIDES ALSO that further considerations on the substitution of the use of polyphosphates as builders in dishwasher detergents for consumer use referred to in paragraph b) should be reconsidered in 2010.

HELCOM RECOMMENDATION 28E/8

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

ENVIRONMENTALLY FRIENDLY PRACTICES FOR THE REDUCTION AND PREVENTION OF EMISSIONS OF DIOXINS AND OTHER HAZARDOUS SUBSTANCES FROM SMALL-SCALE COMBUSTION

THE COMMISSION,

RECALLING Paragraph 1 of Article 6 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the Baltic Sea Area from land-based sources by using, *inter alia*, Best Environmental Practice for all sources and Best Available Technology for point sources,

HAVING REGARD also to Article 3 of the Helsinki Convention, in which the Contracting Parties shall individually or jointly take all appropriate legislative, administrative or other relevant measures to prevent and abate pollution in order to promote the ecological restoration of the Baltic Sea Area,

RECALLING Article 5 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the marine environment of the Baltic Sea caused by harmful substances,

RECOGNISING that small-scale combustion appliances are land-based sources from which considerable emissions of dioxin are likely to reach, directly or indirectly, the marine area,

RECALLING that dioxin compounds are hazardous substances selected for immediate action by HELCOM,

RECOGNISING ALSO that dioxins are toxic and carcinogenic to aquatic organisms, and bioconcentrate at low trophic levels in the aquatic ecosystem,

RECOGNISING ALSO that the release of dioxins arising in domestic combustion appliances can be minimised by applying Environmental Friendly Practices,

TAKING INTO ACCOUNT that abatement measures for dioxins also affect the emissions of other hazardous substances,

NOTING that for the purpose of this Recommendation the following definitions apply:

- “Dioxin” means chlorinated dibenzo-p-dioxin (PCDD) and dibenzofuran (PCDF) compounds;
- “Domestic combustion appliances/small-scale combustion appliances” mean boilers, stoves and open fireplaces, used for domestic heating, cooking, baking, sauna bathing or other, similar purposes generating an input effect of less than 50 kW;
- “Fuel” means solid fuel consisting of pure material of wood, peat or coal,

NOTING ALSO that the purpose of this Recommendation is to prevent and eliminate pollution of the marine environment by the application of Environmentally Friendly Practices for the use of small-scale combustion appliances with a view to limiting emissions of dioxins and other dioxin-like compounds,

NOTING FURTHER that this Recommendation applies to combustion appliances using solid fuel,

RECOMMENDS to the Governments of the Contracting States to take the necessary measures to:

1. Ensure the introduction of the use of an increasing number of low-emission combustion appliances

   - Environmentally sound combustion appliances should be promoted for small-scale combustion installations. Suppliers should be made aware of environmentally sound practices for combustion appliances below 50 kW and should be involved in the promotion of Best Environmental Practises (BEP) for households;
   - At enterprises, annual internal inspections (by the operator) and regular instructions on the proper use of the technical equipment by authorised experts (e.g. professional chimney sweepers) should be recommended or made mandatory,

2. Enhance public awareness

   2.1 Public awareness should be enhanced regarding

   a) importance of environmentally friendly practices to minimise effects of small-scale combustion in domestic and small enterprise furnaces;

   b) purchase of domestic combustion appliances, the preparation and storage of fuel and the operation of the combustion appliances,

   2.2. Public awareness should be enhanced in the abovementioned fields by developing guidelines and arranging information campaigns for households and small enterprises. The information should aim at promoting the following measures and practices:

   a) when new appliances are installed, certified or other products with high environmental performance should be chosen;

   b) only combustion appliances constructed in accordance with the amount of energy required for its purpose should be installed;

   c) combustion appliances should be operated in a way that optimises combustion processes, taking into account at least the following modes of operation:

   (i) fuel:
   - fuel should be prepared and stored in a way that ensures that it is dry when combusted
   - fuel should be homogeneous in quality and size
   - any such waste (plastics, paper, painted wood, etc.) which contribute to the formation of dioxins should not be incinerated or used as fuel; However wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood-preservatives or coating, can be used as fuel

   (ii) loading:
   - each load of fuel should be in accordance with the quantity/size for which the combustion appliance is designed and constructed
   - frequency of loading should be adapted to the combustion appliance and adjusted to maintain good combustion conditions

   (iii) operation:
   - start-up periods should be as short as possible and dry fuels of appropriate size/shape should be used.
   - during the burning period, inlet of air should be adjusted to optimal combustion conditions. Deficit or excess air should be prevented;

   d) combustion appliances should be regularly maintained by removing bottom ash. Chimneys should be regularly swept in order to reduce emission of dioxins and to prevent chimney fire.

RECOMMENDS FURTHER that the Contracting Parties develop in 2008 specific efficiency requirements and emission limit values for small scale combustion appliances,

RECOMMENDS FURTHERMORE that the Contracting Parties report on the implementation of the Recommendation to the Commission, based on reporting requirements developed by the Land-based Pollution Group.

HELCOM RECOMMENDATION 28E/9

Adopted 15 November 2007,
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

DEVELOPMENT OF BROAD-SCALE MARINE SPATIAL PLANNING PRINCIPLES IN THE BALTIC SEA AREA

THE COMMISSION,

RECALLING Article 3 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties declare the application of the precautionary principle, and Article 15 in which the Contracting Parties agree to individually and jointly take all appropriate measures, with respect to the Baltic Sea Area and its coastal ecosystems influenced by the Baltic Sea, to conserve natural habitats and biological diversity and to protect ecological processes,

RECALLING FURTHER HELCOM Recommendation 24/10 on implementation of integrated marine and coastal management of human activities in the Baltic Sea Area and to promote integrated management of human activities having impacts on the marine environment,

RECOGNISING that the network of Baltic Sea Protected Areas forms an integral part of the broad-scale spatial planning, **WE STRESS** that the Contracting Parties must fulfil their obligations under the joint 2003 HELCOM/OSPAR Marine Protected Areas Working Programme by 2010,

BEING CONCERNED about the increasing intensity of human activities in marine and coastal areas causing threats to the environment,

BEARING IN MIND that:

a) the Baltic Sea marine and coastal areas possess a unique biodiversity and resources, the use and protection of which requires special, sustainable and co-ordinated planning and new approaches to the management of human activities;
b) the Ecosystem Approach calls for cross- sectoral management of human activities;
c) the improper use of the marine and coastal areas may result in irreversible changes or long-lasting damage, and thus could affect the sustainable use of marine resources by future generations;
d) marine broad-scale spatial planning is an overarching spatial management method providing tools for comprehensive and integrated coastal and marine management,

BEING AWARE that broad-scale marine spatial planning can help in meeting ecosystem-based management objectives, in reducing user conflicts, and in reducing adverse impacts of human uses now and in the future,

BEING CONCERNED that marine and coastal spatial planning is not carried out on a whole-Baltic scale, in a way that safeguards the marine and terrestrial biodiversity,

RECOGNISING that several components of broad-scale spatial planning are already in place within the Baltic Sea Area, e.g. Marine Protected Areas, Traffic Separation Schemes and the EU and EU-Russian regulations on fisheries management (areas closed to fisheries),

ACKNOWLEDGING
a) the Recommendation of the European Parliament and of the Council concerning the implementation of Integrated Coastal Zone Management in Europe (Recommendation 2002/413/EC);

b) Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE);
c) the proposal for a Directive of the European Parliament and of the Council establishing a Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Directive);
d) the Blue Paper on a Future Maritime Policy for the European Union (Towards a future Maritime Policy for the Union: A European vision for the oceans and seas);
e) the 1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention),

WELCOMING furthermore the activities currently carried out in the Baltic Sea region by several HELCOM Contracting Parties, and within international initiatives, such as VASAB 2010*, Baltic 21 as well as recognising results of INTERREG Projects,

NOTING FURTHER that
a) most of the Contracting Parties have national legislation and policies regarding integrated management of human activities impacting marine and coastal areas,
b) national agencies, private parties and NGOs have roles, interests, concerns and obligations regarding the marine and coastal areas that differ from one another as well as between countries,

ENSURING that all Contracting Parties have free access to the HELCOM GIS database and permission to use the data for the spatial planning activities in their countries,

RECOMMENDS that the Contracting Parties:
a) jointly develop the marine and coastal broad-scale spatial planning common principles to facilitate the protection and sustainable use of the Baltic Sea;
b) fill in data gaps in spatial data e.g. on marine and coastal biodiversity, natural resources, use of land and water areas, demography, traffic, shipping;
c) develop joint solutions to the problems associated with access to spatial data;
d) provide HELCOM and other relevant parties with the necessary spatial data for marine and coastal broad-scale spatial planning;
e) identify and map interacting and/or conflicting interests, obligations and uses of the sea, primarily to broaden the HELCOM GIS as a data source and an effective tool to be used in marine broad-scale spatial planning (compatible with the European Environment Agency database including spatial data);
f) carry out consultations jointly concerning activities which may have transboundary negative effects on the environment and coastal populations.

The implementation of this Recommendation should be evaluated at regular intervals.

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* e.g. the VASAB Recommendation for spatial planning of the coastal zone in the Baltic Sea Region.

HELCOM RECOMMENDATION 28E/10

Supersedes HELCOM Recommendations 19/8, 26/1 and 28/1.

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

APPLICATION OF THE NO-SPECIAL-FEE SYSTEM TO SHIP-GENERATED WASTES AND MARINE LITTER CAUGHT IN FISHING NETS IN THE BALTIC SEA AREA

THE COMMISSION,

RECALLING Article 8 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (the Convention) which calls for development and application of uniform requirements for the provision of reception facilities,

RECALLING ALSO Article 9 of the Convention stipulating a need for special measures in relation to pleasure craft, which includes the establishment of adequate reception facilities for wastes from pleasure craft,

CONSCIOUS that the "no-special-fee" system constitutes a system with the dual purpose of encouraging ships to deliver waste ashore and to avoid undesirable waste streams between ports, thereby encouraging a sound sharing of the waste burden,

CONSCIOUS ALSO that the no-special-fee system constitutes one of the prerequisites for a substantial decrease in the number of operational and illegal discharges and thus for the prevention of pollution of the marine environment from ships,

NOTING that the port authorities are responsible for providing reception facilities for wastes covered by Annex I (oil), Annex II (noxious liquid substances), Annex IV (sewage) and Annex V (garbage) of the 1973 International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978 relating thereto (MARPOL 73/78),

NOTING ALSO that the consignor in the loading port is responsible for reception arrangements for cargo-related wastes covered by Annex I (oil residues from cargo tanks) of MARPOL 73/78,

NOTING FURTHER that the consignee in the unloading port is responsible for reception arrangements for wastes covered by Annex II (residues of noxious liquid substances) of MARPOL 73/78,

RECOMMENDS that the Governments of the Contracting Parties apply the attached Guidelines for the establishment of a harmonised "no-special-fee" system for the operation of reception facilities in their ports as of 1 January 2000 for ship-generated wastes covered by Annex I (oily wastes from machinery spaces) of MARPOL 73/78 and as of 1 January 2006 for wastes covered by Annex IV (sewage) and Annex V (garbage) of MARPOL 73/78,

RECOMMENDS ALSO that the litter caught in fishing nets be covered by the “no-special-fee” system,

TAKING NOTE of the adoption within the European Union of Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues,

REQUESTS the Contracting Parties to support or seek active co-operation with the North Sea States for the purpose of establishing a similar "no-special-fee" system also in the North Sea Region,

REQUESTS ALSO the Governments of the Contracting Parties to report on the implementation of this Recommendation and attached Guidelines in accordance with Article 16(1) of the Convention.

Attachment

Guidelines for the establishment of a harmonised "no-special-fee" system for the delivery of ship-generated oily wastes originating from machinery spaces and for the delivery of sewage and garbage, including marine litter caught in fishing nets, to port reception facilities

1 Definition of the "no-special-fee" system

1.1 In this context the "no-special-fee" system is defined as a charging system where the cost of reception, handling and disposal of ship-generated wastes, originating from the normal operation of the ship, as well as of marine litter caught in fishing nets, is included in the harbour fee or otherwise charged to the ship irrespective of whether wastes are delivered or not.

1.2 The "no-special-fee" system is not restricted to any specific type of ship-generated waste.

2 Obligation to pay

2.1 Every sea-going ship's obligation to pay for reception, handling and disposal of oil residues, sewage and garbage is deemed to arise with the arrival of a ship in any port of the participating countries, irrespective of whether or not that particular ship will actually make use of the reception facilities, which are available there.

2.2 The above fee covers the waste collecting, handling and processing including infrastructure and shall be distributed among ships and collected as part of or in addition to the port dues.

3 Exemptions

3.1 A ship may be exempted by the competent authority from the obligation to pay, when engaged in regular services and it is ensured that the disposal requirements will be met on the ship’s own account.

3.2 For the purpose of these Guidelines "regular services" means a series of ship crossings operated so as to serve traffic between the same two or more ports, or a series of voyages from and to the same port without intermediate calls, either:

(i) according to a published timetable, or

(ii) with crossings so regular or frequent that they constitute a recognisable schedule.

A crossing should be considered as frequent if the ship visits the port once a fortnight.

3.3. When a ship applies for an exemption, the competent authority of the Port State should require evidence of the ship’s scheduled traffic as well as evidence of waste management practice (contract, receipts, copy of garbage record book, oil record book etc.). The ship has to organise its waste management according to a contract and deliver its waste regularly under this arrangement in a certain port/ports. If it chooses to deliver elsewhere, a port can charge the ship according to the real costs (direct fee).

3.4. The Contracting States should also inform about the issued exemptions to other Port States along the scheduled route. The Contracting States will inform the HELCOM Secretariat of their competent authority responsible for granting exemptions from the mandatory delivery and notification requirements.

4 Basis of calculation of the no-special-fee

4.1 The waste management fee imposed on a ship should be independent of the volume of the wastes delivered to the port reception facilities. To obtain the maximum of truth and fairness in specifying the ship’s contribution to the no-special-fee system the gross tonnage, as indicated in the vessel's Data Sheet, could be taken as the basis of calculation by the port. Basis of calculation of oil, garbage and sewage may depend on the type and size of the ship as well as the number of crew and passengers.

4.2 A high quality standard of the applied waste management procedures and waste processing equipment on board can also be taken into account in scaling the waste management fee, having in mind the general aim of minimisation of waste production, and the benefit of waste separation.

4.3 The waste management fee shall be fair, transparent and non-discriminatory to all ships, i.e. the size of the waste management fee shall be visible to every ship even if it is included in the harbour fee.

4.4 The waste management fees received from ships shall be used for no other purposes than:

- investments in reception facilities, stationary and mobile;
- operation of reception facilities;
- repair and maintenance costs of such facilities;
- costs of handling, treatment and final disposal of the received wastes.

5 Avoidance of competitive distortion

5.1 To avoid competitive distortions between ports located in different sea areas, all possible efforts shall be made to achieve as soon as possible a harmonised waste management fee system for the ports in the Baltic Sea and in the North Sea Regions.

5.2 The Contracting States involved shall make the necessary efforts in order to implement a harmonised fee system simultaneously in the ports of the Baltic Sea as well as in the North Sea Regions.

5.3 Provisions should be made to preclude any subsidising of the waste management fee through public funds for the operation of reception facilities.

5.4 The Governments of the Contracting States shall exchange periodic reports on the implementation of these Guidelines in their ports, including reports on the financing and operation of reception facilities, and evaluate such reports at the meetings of the Maritime Group of the Helsinki Commission.

HELCOM RECOMMENDATION 28E/11

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

FURTHER MEASURES TO IMPROVE THE SAFETY OF NAVIGATION IN ICE CONDITIONS IN THE BALTIC SEA

THE COMMISSION,

BEING CONSCIOUS that parts of the Baltic Sea are ice-covered for several winter months, which places some limitation on maritime transportation and entails greater risks of accidents and pollution,

NOTING the increasing vessel traffic and especially transportation of oil products in the Baltic and the expected future significant growth of shipping activities in general,

BEING AWARE of the technical difficulties in responding to oil spills in ice,

BEING FURTHER AWARE that the increasing vessel traffic will also increase demands for icebreaking services, especially during severe winters and in difficult ice conditions,

OBSERVING that the capability of vessels to navigate in ice has constantly improved due to the technological development, while there seems to be a lack of relevant experience and know-how among the ship crews, and that the risk of accidents during ice conditions can be decreased by well-trained and experienced ship crew,

RECOGNISING that timely and reliable information on ice conditions, recommended routes and available icebreaking services are of crucial importance when assisting the ships in their route through the Baltic,

RECALLING the Declaration on the Safety of Navigation and Emergency Capacities in the Baltic Sea Area (HELCOM Copenhagen Declaration) adopted on 10 September 2001 in Copenhagen,

BEING CONVINCED of the need for further measures to advance the safety and efficiency of winter navigation in the Baltic Sea and to create unified rules and regulations and operational practises for navigation in ice conditions,

ACKNOWLEDGING the successful development of co-operation among maritime authorities from all the Baltic Sea Coastal States within the framework of the Baltic Icebreaking Management organisation,

WELCOMING closer exchange of information with Baltic Icebreaking Management (BIM) in order to join forces of the two organisations: HELCOM as environmental policy-maker on one side and BIM as a platform for exchange of information and knowledge related to navigation in ice conditions on the other,

APPRECIATING the initiative by BIM to create a single source of timely and reliable information on ice conditions, traffic restrictions, icebreakers and other issues relevant to mariners navigating in the Baltic Sea during wintertime, which can be obtained from the website www.baltice.org,

RECOMMENDS that the Governments of the Contracting States take necessary steps to ensure that there are sufficient icebreaking services available to assist ships bound for ports in their territory,

RECOMMENDS FURTHER that the Governments of the Contracting States, when arranging icebreaking services, try to prioritise the provision of service according to the risk areas, including heavy traffic routes, routes to oil terminals, ports with a large number of calls in ice conditions, and others,

RECOMMENDS FURTHERMORE the Governments of the Contracting States to advance educational offers for seafarers of high quality training programmes in navigation in ice conditions according to the 1978 International Convention on Standards in Training, Certification and Watchkeeping for Seafarers. Such training programmes should provide knowledge, understanding and proficiency required for operating a ship in ice-covered waters, including:

- ice conditions, ice types and ice chart;
- ice classes, ship's construction and traffic restrictions;
- icing and winterisation;
- voyage planning and operation in ice;
- icebreakers and assistance,

RECOMMENDS ALSO the Contracting Parties to promote the use of the Electronic Chart Display and Information System (ECDIS) and the use of qualified Baltic Sea Pilots during their voyage in the Baltic Sea in ice conditions until the Master or Senior Watchkeeping Officer of the vessel has achieved sufficient experience in winter navigation,

INVITES experts on icebreaking within BIM to contribute to the relevant work of the HELCOM Maritime and Response Groups,

REQUESTS the Governments of the Contracting States to implement the above mentioned measures as soon as possible and to report on the implementation of this Recommendation in accordance with Article 16, Paragraph 1 of the Helsinki Convention.

HELCOM RECOMMENDATION 28E/12

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

STRENGTHENING OF SUB-REGIONAL CO-OPERATION IN RESPONSE FIELD

THE COMMISSION,

BEING AWARE that the increasing maritime traffic is causing a potential threat of a pollution incident at sea,

BEING ALSO AWARE that spills of oil or other harmful substances can have a long-lasting harmful impact on the sensitive marine environment and the coastal areas of the Baltic Sea,

RECOGNISING the efficiency of an operational "three tier" approach for planning and response to pollution incidents in the Baltic, whereby minor oil spills are addressed by one Contracting State, spills of medium size are addressed by well-organised and timely action by several Contracting State located in the vicinity of the accident, and the largest spills are addressed by the co-ordinated efforts of all Contracting Parties and, if necessary, with use of external assistance,

NOTING the significance of sub-regional approach to ensure timely and well-organised emergency towing, fire-fighting and lightering and, if needed, response to a pollution incident, including shoreline response, and in that way to minimise environmental damage caused by an accident,

NOTING FURTHER that sub-regional co-operation is of crucial importance when effectively using the emergency and response resources,

RECOMMENDS that the Contracting Parties take necessary steps to assess the risk of oil and chemical pollution and on that basis review emergency and response resources on a sub-regional basis in order to ensure that:

1. there are sufficient emergency resources in the area to provide adequate emergency towing, fire-fighting and lightering capacity to a ship in need of assistance within a reasonable period of time;
2. there are sufficient response resources/capacity to ensure effective collection of pollutants in case of a "medium-size" pollution incident or to control large-scale pollution incidents until the assisting forces arrive on the scene;
3. there is adequate response capacity to enable effective shoreline response,

RECOMMENDS ALSO that the Contracting Parties draw up bilateral or multilateral agreements and/or response plans for major risk areas and/or dangerous objects located in the vicinity of their borders and where co-ordinated efforts are needed to ensure adequate response to pollution incidents,

RECOMMENDS FURTHER that the Contracting States cooperate by carrying out joint surveillance operations and/or flights by one Contracting State over the responsibility area of the other Contracting State(s) in order to ensure that the minimum HELCOM requirements on aerial surveillance are fulfilled,

RECOMMENDS ADDITIONALLY that the Contracting States endeavour to do their best in order to ensure that a ship in need of assistance would be accommodated in the most appropriate place of refuge without undue delay,

RECOMMENDS FINALLY that the Contracting States integrate shoreline response into national contingency plans, and cooperate by conducting trainings and organising exchange programmes to ensure swift and adequate response capacity and to develop best practices.

Attachment

Guidance for sub-regional plans to quantify needed emergency/response resources

The idea of enhanced sub-regional co-operation, which has been discussed and agreed in HELCOM RESPONSE, rests on a four-step logic:

- Analysis of the likely accident scenarios taking into account sub-regional specifics;
- Identification (both quantitative and spatial) of the emergency and response resources needed sub-regionally to respond to an accident of Tier 1 and 2 and how to deal with a Tier 3 accident until the assistance arrives;
- Comparison of the identified needs to the available resources and development of plans to meet the needs for resources in the sub-region in the most effective way;
- By the above standing steps, achieving adequate emergency and response preparedness in the most cost-efficient way.

Even though the risks and likely accident scenarios certainly vary sub-regionally, it might be beneficial to have a general discussion on certain aspects of the assessments in order to facilitate sub-regional actions:

- Likely maximum accident for which the sub-regions should be prepared;
- Principles for the estimation of the needed emergency and response resources as well as their preparedness and spatial allocation.

Emergency towing

Every sub-region should have adequate emergency towing capacity to be able to handle the largest vessels sailing in the region in rough sea conditions (e.g. Beaufort 10-12 in the Baltic Sea).

Spatial allocation and preparedness should correspond to the time limits for approaching and securing a ship in distress along the major shipping lane(s) in the sub-region before it reaches shallow waters.

Emergency lightering

Emergency lightering capacity (pumping capacity, intermediate storing and possible places of refuge) should be analysed for a lightering operation of the biggest ships sailing in the area (up to 150,000 tonnes).

Emergency fire fighting

Emergency fire fighting capacity should ensure at least availability of Fire Fighters class 1 according to Det Norske Veritas (DNV) or similar (around 20,000 litres/minute).

Places of refuge

Based on risk assessment in a sub-regional context, including evaluation of the environmental factors, adequate response capacities should be available for places of refuge.

Shoreline response

Every sub-region should have adequate equipment and trained personnel to protect the coast, especially vulnerable habitats and areas (Baltic Sea Protected Areas, BSPAs) and to ensure immediate and appropriate action on shore.

Shoreline response capacity should be addressed and arranged in its complexity within sub-regional agreements between adjacent Contracting States. Such agreements are aimed at ensuring fast and sharp reaction when a second and/or third tier or transboundary pollution accident has occurred.

The logic described in HELCOM Recommendation 11/13 serves as a basis to analyse and utilise the personnel, amount and type of booms, skimmers, vacuum cleaners, washers and other relevant equipment needed to maintain readiness for actual operations in such accidents.

All priorities related to vulnerable areas (BSPAs) are to be pre-planned within sub-regional action plans; this may include wildlife response as deemed feasible.

Response capacity

Response capacity should be available for responding to a 1,000- 5,000 tonnes (depending on the likely accident in the area) oil spill at sea in favourable weather within 3 days. Local geographical and other specifics (e.g. archipelago area, shallow water, etc.) should be taken into account.

Action Plan

When the above standing analysis has been performed, there should be an action plan for how together to improve the capacity. Who buys what and when? How do the others get hold of it in an emergency situation, etc.

Notification

NB -There is no need for special alarm procedures, etc. Normal HELCOM routines should be applied, but of course it is permitted to call or mail the sub-regional partners as a first notification.

HELCOM RECOMMENDATION 28E/13

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b) and Annex II
of the Helsinki Convention

INTRODUCING ECONOMIC INCENTIVES AS A COMPLEMENT TO EXISTING REGULATIONS TO REDUCE EMISSIONS FROM SHIPS

THE COMMISSION,

BEING AWARE that pollution from shipping has negative impacts on the sensitive marine environment of the Baltic Sea,

ACKNOWLEDGING that, although there has been general substantial progress achieved in improving the protection of the marine environment of the Baltic Sea and in reducing the airborne emissions from shipping in particular, there is still a need for further emission reduction,

ACKNOWLEDGING the importance of a review of Annex VI to MARPOL 73/78 and other international measures to reduce emissions from ships,

STRESSING the need for introducing new and effective solutions to curb emissions from shipping,

RECOGNISING the need to evaluate and implement additional alternatives to the existing regulatory measures to reduce emissions from shipping,

RECALLING Annex II to the Helsinki Convention **AND NOTING** that the promotion and use of Best Environmental Practice and Best Available Technology can be triggered by the application of economic instruments to activities, products and emissions in the Baltic Sea Area and may constitute an effective means to reduce emissions from shipping,

NOTING FURTHER that economic incentives can serve as complements to regulatory measures and thereby may lead to a larger reduction of pollution compared to that achieved by traditional regulations and can stimulate technological improvements and innovations as well as achievement of environmental results at lower costs,

BEING CONVINCED that sub-regional co-operation is of crucial importance also when the desire is to effectively use economic instruments,

RECOMMENDS that the Contracting Parties investigate and, when appropriate, introduce feasible and effective economic instruments as a possible complement to existing regulations to further reduce air pollution from shipping,

RECOMMENDS FURTHER that the Contracting Parties take into consideration the attached **Guidelines** when introducing economic incentives schemes to reduce emissions from ships.

Attachment

Guidelines for introducing economic incentive schemes as a possible complement to existing regulations to reduce emissions from ships in the Baltic Sea Area

These guidelines are intended to give advice to the Contracting Parties to the Helsinki Convention to introduce incentive schemes to reduce air pollution from ships calling upon Baltic Sea ports.

1. Introduction

The shipping sector is not regulated as extensively as land-based sources and, as a result, in contrast to the expected progress in reducing emissions from land-based sources, shipping emissions of NOx and SOx are expected to continue to increase. Due to the international nature of shipping, the measures adopted at the national or regional level can only have limited impact on emissions from shipping in the specific region. All Contracting States must therefore take active part in global actions initiated within the IMO to substantially reduce emissions from ships. These measures form the international baseline upon which there often is room for regions or nations to introduce non-discriminatory economic incentives to further reduce pollution from ships within their jurisdiction.

2. Definitions of Economic Incentives

Economic incentives defined broadly are instruments that use financial means to motivate actors to reduce health and environmental risks posed by their facilities, processes, or products. These incentives provide monetary rewards for those polluting less and impose costs of various types for those polluting more, thus supplying the necessary motivation of change to polluters. This approach provides an opportunity to address sources of pollution at an overall cost that is lower than traditional forms of regulation as well as providing a reason for polluters to improve in addition to existing regulatory requirements.

3. Existing financial instruments

Economic instruments to encourage environmentally friendly or quality shipping have been introduced in some countries and ports around the world to encourage ship owners to reduce their atmospheric emissions. These include differentiated port and fairway dues, differentiated taxation of marine fuels and differentiated tonnage taxes. However, those measures when taken only on a national level might have a limited effect on the overall emissions from shipping. To achieve a substantial emission reduction, a much broader incentive scheme, a common Baltic or European system of economic incentives, is needed. The system should be flexible in order to permit national and local differences to be catered for. However, it does not need to be necessarily restricted by the peculiarities of Contracting States' national institutional arrangements concerning shipping dues. Environmentally differentiated fairway dues or other incentive schemes limited to ships calling at Baltic Sea ports can be introduced without conflict to the right of innocent passage provided by 1982 United Nations Convention on the Law of the Seas (Article 26).

4. Proposed financial structure for introducing economic incentives

All countries around the Baltic Sea have some kind of financial system that enables provision of services to shipping, infrastructure investments, dredging, lighthouse and fairway maintenance, icebreaking, hydrological surveys, etc. Taking into consideration the diversity of financial systems applied in the Baltic Sea countries and to allow some flexibility in introducing economic incentives, this proposal allows the Contracting Parties to consider the introduction of economic incentives to reduce emissions from shipping in addition to local financial systems. There are three options for introducing economic incentives that Contracting Parties may choose between:

- to introduce a system of environmentally differentiated fairway dues;
- to modify an existing charging system to allow environmental differentiation of dues;

- to add an emission fee with subsequent differentiation on top of their present system.

There are, however, some requirements that should be followed regardless of which incentive scheme is considered or subject to be implemented. An incentive scheme should have the following prerequisites:

- It should offer the best possible protection of the environment;
- It should cover all important aspects (management, design/equipment, ship operation);
- Emission charges are suitable for ships of all flags, 400 GT and above, visiting Baltic ports;
- The system should be reliable and easy to implement;
- Evidence of compliance should be simple;
- Expenses for the operators of the system should be low.

It is important that the level of charge is accurately set. This would create a zero-sum game for the industry as a whole. Since ferry traffic is responsible for mainstream emissions in ports* these ships would need to be actively involved in the incentives schemes. The dues levied per unit of the vessel's gross tonnage might be differentiated with the introduction of lower levels for passenger vessels and cruise liners if so desired. When introducing an incentive scheme, the following measures should be considered:

- to establish levels for NOx and SOx emissions (or to lower the existing ones) based on which rebate schemes for NOx and SOx will be developed;
- to decide a minimum fee based on gross tonnage or installed engine power (might differ for different categories of ships);
- to decide on number of calls subject to dues (for instance, five calls per calendar month for Ro/Pax and passenger ferries and two calls for other vessels);
- to consider a revenue-neutrality resulting in higher dues for more polluting ships and rebates for ships that invest in emission abatement technologies depending on achieved results.

The following rebate schemes for reducing NOx and SOx emissions might be used.

Nitrogen oxide discount

The Contracting Parties might consider an entrance reduction limit for discounts as 10 g per kWh. The scale extends below 0.5 g/kWh. The lowest limit set up to 0.5 g/kWh would provide a stronger incentive to include auxiliary engines in measures to cut NOx emissions. The table below constitutes an example of how the dues after discount per unit of the vessel's gross tonnage could be applied.

Emission level, gram NOx/kWh	Ro-Pax and passenger vessels, €	Cruise vessels, €	Oil tankers. €	Other vessels, €
0 – 0.50	0.064	0.042	0.107	0.096
0.51 – 1.00	0.075	0.053	0.118	0.107
1.01 – 2.00	0.096	0.059	0.139	0.123
2.01 – 3.00	0.116	0.064	0.159	0.142
3.01 – 4.00	0.125	0.069	0.168	0.152
4.01 – 5.00	0.135	0.075	0.178	0.162
5.01 – 6.00	0.145	0.080	0.188	0.172
6.01 – 7.00	0.154	0.085	0.197	0.182
7.01 – 8.00	0.164	0.091	0.207	0.191
8.01 – 9.00	0.174	0.096	0.217	0.20
9.01- 10.00	0.183	0.102	0.226	0.21
10.01 -	0.193	0.107	0.236	0.22

* *Ferry and Ro-Ro traffic is responsible for about 75 % of energy consumption of ships calling upon Swedish ports*

Monitoring, reporting and control

Currently it is not possible to continuously measure the exact amount of different pollutants being emitted from individual ships. Until the monitoring technologies are developed and available, emissions will have to be estimated. The calculation can make use of data on the amount of NOx and SOx that is released by vessel's main engines for each kilowatt-hour at 75% of utilised engine capacity.

MARPOL Annex VI sets limits on emissions of NOx from diesel engines. The NOx Technical Code stipulates how this shall be done. The method in the Code can also be used to establish emission levels below the mandatory value.

Measurements of the emission levels from individual vessels shall be conducted by an accredited control laboratory (authorised authority) according to ISO 8178 and the provisions of the NOx Technical Code. The laboratory issues a survey report and a NOx attestation. The Maritime Administration or the recognised organisation (classification society) acting on behalf of that Administration issues the NOx Certificate. Certificates issued by the Administration of a Contracting State shall be recognised by another Contracting State.

The survey report shall specify which measures are taken onboard the ship to continuously reduce NOx emissions as well as information on how the monitoring and verification shall proceed.

NOx certificate

Based on the conducted survey report that shows that the abatement technology is installed and that the calculated weighted emission of NOx is less that 10 g/kWh, the accredited laboratory may issue a NOx reduction attestation. This attestation shall demonstrate the NOx emission level measured and adjusted for ambient factors and recalculated to nitrogen dioxide (NO_2/kWh) in grams with two decimals at 75% power output and steady-state running conditions for main engines (ME) and 50% for auxiliary engines (AE).

Sulphur-related dues and discount

According to Directive 1999/32/EG relating to a reduction in the sulphur content of certain liquid fuels or marine gas oil (MGO) may not be used in EU territorial waters if their sulphur content exceeds 0.2%. Directive 2005/33/EC amending the Directive 1999/32/EG requires from 1 January 2010 a maximum limit of 0.1% sulphur by weight for marine fuels used by inland waterways vessels and ships at berth in Community ports. The directive does not cover heavy fuel oil (HFO) or the fuel in the bunker tanks of ships passing the border between EU and non-EU countries. The economic incentives (environmental differentiation of fairway or other dues aimed at providing an incentive for vessels to use low-sulphur bunker fuel oil) must now be adjusted to prevailing rules. Although most vessels that utilise marine fuel covered by the directive are obliged to use bunker fuel oil with a sulphur content less than 0.2 percent by weight, these vessels should be given a certain discount, as there might otherwise be a risk for their switch to HFO. Moreover, a certain stimulus should be given to vessels not covered by the directive.

The table below shows an example of the sulphur-related dues calculated per unit of the vessel's gross tonnage that might be introduced for all types of ships.

Sulphur content, percent by weight	Ro-Pax and passenger vessels, €	Other vessels, €
0 – 0.2	0	0
0.21 – 0.5	0.032	0.021
0.51 – 1.0	0.064	0.042
1.01 -	0.064	0.064

The significance of passenger vessels in curbing sulphur emissions to the atmosphere corresponds to the difference in the incentive structure vis-à-vis other vessels, as shown in the table.

SOx emissions, Sulphur attestations and certificates for abatement technology

The emission of sulphur from ships is proportional to the sulphur content of the bunker fuel oil if no abatement technologies are applied. According to MARPOL Annex VI, ships have to carry a Bunker Delivery Note (BDN), which provides information on the sulphur content of the fuel. In order to be qualified for deduction, the ship owner has to fill in a sulphur attestation stating the continuous operation on low-sulphur fuel verified by BDN and samples.

If an abatement technology to reduce emissions of SOx is applied, the Maritime Administration or recognised organisation acting on behalf of that Administration shall conduct a survey report specifying which measures are taken onboard the ship to continuously reduce SOx emissions. The survey report shall also contain information on how the monitoring, control and verification shall proceed. If the installation is approved, the Maritime Administration will issue a certificate. Certificates issued by the Administration of a Contracting State shall be recognised by another Contracting State.

HELCOM RECOMMENDATION 28E/14

Adopted 15 November 2007
having regard to Article 20, Paragraph 1 b)
of the Helsinki Convention

DEVELOPMENT OF HARMONISED PRINCIPLES FOR QUANTIFYING DIFFUSE LOSSES THROUGHOUT THE BALTIC SEA CATCHMENT AREA

THE COMMISSION,

RECOGNISING that a goal of the HELCOM Baltic Sea Action Plan is to achieve good ecological status of the marine environment of the Baltic Sea, and the need to quantify the future inputs of nutrients to the whole Baltic Sea and its sub-regions in order achieve the HELCOM Ecological Objectives under the goal "Baltic Sea unaffected by eutrophication",

RECALLING that existing methods and catchment models are able to describe and assess different loss processes and pathways. However, it is difficult to quantify losses from diffuse sources accurately and to consider the various natural and anthropogenic components of the discharges/losses regime of nitrogen and phosphorus in the river systems,

BEING AWARE that

- currently no common methodology has been agreed to quantify diffuse sources or delivery pathways;
- there is a clear need to improve these issues for future HELCOM Pollution Load Compilations;
- any common methodology must be designed for application in catchment areas with different physical characteristics,
- the HELCOM Baltic Sea Action Plan also requires an estimate as exact as possible on diffuse sources entering into the Baltic Sea;
- the existing information and results from ongoing projects in HELCOM and OSPAR areas (e.g. the outcome of the EU-funded EUROHARP Project and the OSPAR HARP-NUT Guideline 6 on diffuse sources) should be taken into account,

ACKNOWLEDGING the need of harmonized principles for quantifying diffuse losses throughout the Baltic Sea catchment area in order to obtain comparable and reliable estimates on the waterborne inputs from both point sources and diffuse sources entering into the Baltic Sea. The information is required to enable better assessments whether HELCOM reduction targets are met and as well to improve the possibilities to assess the effectiveness of different measures taken,

TAKING INTO CONSIDERATION that the implementation of this HELCOM Recommendation will result in improved knowledge and more reliable results of inputs from especially diffuse sources for future Pollution Load Compilation assessments and as basis for decisions to be taken for the HELCOM Baltic Sea Action Plan,

RECOMMENDS the Contracting Parties to the Helsinki Convention:

1. to support the development and use of harmonised principles for quantifying losses and inputs from diffuse sources;

2. to monitor, calculate and report complete data sets on point and diffuse source nutrient loads, so the total loads entering the Baltic Sea can be estimated with reasonable accuracy bearing in mind the requirements of the HELCOM Baltic Sea Action Plan

- in developing targets for good ecological status;
- in estimating future allowable nutrient inputs to the Baltic Sea and its sub-regions without jeopardize achieving the good ecological status;

3. to support further division of total diffuse losses between different sources (e.g. agriculture, managed forests, natural background) as well as to estimate the retention rates nitrogen and phosphorus in the catchment;

4. to include the loads coming from upstream countries in a more comprehensive way when quantifying losses from diffuse (as well as from point) sources,

REQUESTS FURTHER HELCOM Monitoring and Assessment Group to follow the implementation of this Recommendation in accordance with Article 16, Paragraph 1 of the Helsinki Convention,

AUTHORISES the HELCOM Monitoring and Assessment Group to adopt technical guidelines for the implementation of this Recommendation.

Other documents to be adopted by the HELCOM Ministerial Meeting on 15 November 2007 in Krakow, Poland

Other documents to be adopted by the HELCOM Ministerial Meeting on 15 November 2007 in Krakow, Poland

Indicators and targets for monitoring and evaluation of implementation of the Baltic Sea Action Plan

In order for the ecological objectives to be operational, initial indicators with set initial targets have been agreed upon. The set targets, when reached, reflect the good ecological status.

Eutrophication

It has been decided that the ecological objectives for eutrophication will be measured by the following indicators:

- Winter surface concentrations of nutrients reflecting the ecological objective "Concentrations of nutrients close to natural levels"
- Summer Secchi depth reflecting the ecological objective "Clear water"
- Chlorophyll *a* concentrations reflecting the ecological objective "Natural level of algal blooms"
- Depth range of submerged vegetation reflecting the ecological objective "Natural distribution and occurrence of plants and animals"
- Area and length of seasonal oxygen depletion reflecting the ecological objective "Natural oxygen levels".

The transparency of seawater integrates many of the concrete effects of eutrophication and has been chosen as the primary ecological objective with summertime (June-September) Secchi depth as an indicator. The other indicators can be regarded as supportive indicators to give additional information on whether good environmental status has been achieved and are dealt with elsewhere.

Target levels for water transparency are defined by acceptable deviation from reference levels reflecting historical, non-impacted status. As a pragmatic approach, the maximum deviation from reference level should not exceed 25%.

Table 1. The initial target and present levels for summertime water transparency in the different sub-regions

Sub-basin (# of EUTRO assessment table)*	Transparency (summer-August) [m]		
	Reference (EUTRO)	Target (25% deviation from reference)	Present situation (EUTRO)
Bothnian Bay (EUTRO 40)	7.5	Present situation	5.8
Bothnian Sea (EUTRO 38)	9.0	Present situation	7.0
Gulf of Finland (EUTRO 31)	8.0	6.0	4.1
Gulf of Riga (EUTRO 25)	6.0	4.5	3.4
Kattegat (EUTRO 1)	10.5	Present situation	8.5
Baltic Proper (mean calculated from EUTRO 30, 28 & 17)	9.3	7.0	6.3

*Development of tools for assessment of eutrophication in the Baltic Sea (BSEP No. 104)

Hazardous substances

Substances or substance groups of specific concern to the Baltic Sea

Substances or substance groups of specific concern to the Baltic Sea.
1. Dioxins (PCDD), furans (PCDF) & dioxin-like polychlorinated biphenyls
2a. Tributyltin compounds (TBT)
2b. Triphenyltin compounds (TPhT)
3a. Pentabromodiphenyl ether (pentaBDE)
3b. Octabromodiphenyl ether (octaBDE)
3c. Decabromodiphenyl ether (decaBDE)
4a. Perfluorooctane sulfonate (PFOS)
4b. Perfluorooctanoic acid (PFOA)
5. Hexabromocyclododecane (HBCDD)
6a. Nonylphenols (NP)
6b. Nonylphenol ethoxylates (NPE)
7a. Octylphenols (OP)
7b. Octylphenol ethoxylates (OPE)
8a. Short-chain chlorinated paraffins (SCCP or chloroalkanes, C_{10-13})
8b. Medium-chain chlorinated paraffins (MCCP or chloroalkanes, C_{14-17})
9. Endosulfan
10. Mercury
11. Cadmium

Substance relevant sectors of the 11 hazardous substances / substance groups of specific concern to the Baltic Sea

Substance	**Main uses potentially relevant for the HELCOM area** (Current regulatory actions for these substances in different Contracting Parties have not been presented in the table)
Organic substances	
1. Dioxins (PCDD), Furans (PCDF) and Dioxin-like Polychlorinated Biphenyls Chosen as indicator for objective 1 and objective 2	Main sources to air: (http://ec.europa.eu/environment/dioxin/sources.htm): - Residential combustion - Open burning of waste (backyard burning) - Iron and steel industry - Power production, non-ferrous metals, chemical industry
2a. Tributyltin compounds (TBT) Chosen as indicator for objective 1	- Use as anti-fouling agent (main use) - Use as biocide - Use as pesticide - Use as marking agent in manufacture of aircraft - Use as fungicide in “regular” (non-anti-fouling) paints - Mono- and dibutyltin, which are used as stabilisers in e.g. PVC, polyurethane, polyester, can include TBT as impurity
2b. Triphenyltin compounds (TPhT)	- Use as anti-fouling agent (main use) - Use as biocide - Use as pesticide (fungicide)
3a. Pentabromodiphenyl ether (pentaBDE)	- Use as flame retardant in plastic used in electrical equipment such as computers (e.g. in electronic circuits) - Use as flame retardant in different textiles used in special work wear (designed e.g. to protect humans) and special carpets - Use as flame retardant in different products made of flexible polyurethane foam such as in furniture, mattresses, parts of cars and packing material (main use) - Use in resin used as raw material for above-mentioned plastic polymers
3b. Octabromodiphenyl ether (octaBDE)	- Use as flame retardant in insulated wires and cables used in different electronic equipment such as computers - Use as flame retardant in different plastic products made of polymers such as ABS and HIPS (main use) - Use as flame retardant in different textiles made of polymers PBT, polyamide (e.g. nylon), PE-LD and polycarbonate polymers - Use in resin used as raw material for above-mentioned plastic polymers
3c. Decabromodiphenyl ether (decaBDE)	- Use as flame retardant in different plastic products made of HIPS used e.g. in shell structures of TVs and monitors and in wires and cables of electrical equipment - Use in textiles such as in curtains, upholstery fabrics and carpets containing polypropylene - Use in resins as raw material for above-mentioned plastic polymers
4a. Perfluorooctane sulfonate (PFOS) Chosen as indicator for objective 1	Main uses: - Use as surface-active agent in waxes and floor polishes - Use as dirt rejecter, friction control agent, surfactant and antistatic agent in photographic industry in manufacturing of photo film, paper and plates and developing photos (main use and high emission factor to wastewater) - Use in semiconductor industry in photo-acid generators, antireflective coatings, etch mixtures and photo-resists (high emission factor to wastewater) - Use as surface-active agent in metal surface treatment in chromium bath used in e.g. chromium plating (main use and high emission factor to wastewater). Important applications / final products are e.g. aircraft and vehicles - Use in fire-fighting foams (high emission factor to wastewater) - Use as surfactant in industrial and household cleaning products - Use as flame retardant, corrosion inhibitor and surface-active agent in

	hydraulic fluids of both civil and military airplanes - Use as water and oil repellent in surface treatment (impregnation) of textiles and leather - Use as water and grease repellent in surface treatment (impregnation) of paper and cardboard (high emission factor to wastewater)
4b. Perfluorooctanoic acid (PFOA)	- Use as fluxing agent in plumbing with leaded soldering tin - As impurity in polytetrafluoroethylene (PTFE) fluoroplastic coatings (in primer and topcoat) applied in many sorts of products. PFOA is used as processing aid in manufacture of fluoropolymers such as PTFE - Normally, PFOA is not intentionally part of the final products (unlike PFOS), but there are residual contents in e. g. fluorpolymer. PFOA can be formed through the transformation or metabolism of PFOA related substances such as telomere alcohols.
5. Hexabromocyclododecane (HBCDD)	- Use as flame retardant in four principal product types: 1. Expandable Polystyrene (EPS, main use), which (as foam containing HBCDD) is further used in the building and construction industry in end products such as insulation panels / boards in the construction sector, automobile cushions for children, rigid packaging material for fragile equipment, packaging material such as ”chips” and shaped EPS-boards 2. Extruded Polystyrene (XPS, main use), which is further used e.g. in rigid insulation panels/boards in the construction sector, insulation material protecting against frost damage on road and railway embankments and sandwich construction in e.g. caravans and lorry platforms 3. High Impact Polystyrene (HIPS), which is further used in electrical and electronic appliances such as audio-visual equipment cabinets (video and stereo equipment), distribution boxes for electrical lines in the construction sector and refrigerator lining 4. Polymer dispersion for textile finishing (coating, significant source); textiles can be used for e.g. flat and pile upholstered furniture (residential and commercial furniture), upholstery seats in transportation, draperies, and wall coverings, bed mattress ticking, interior textiles e.g. roller blinds, automobile interior textiles and car cushions
6a. Nonylphenols (NP)	- Use as raw material for production of NPE - Use as stabiliser and emulsifying agent in paints, varnishes and coatings - Use as adhesive or binding agent, process regulator, stabiliser and hardener for epoxy resin in manufacture of plastic products such as in construction materials and as soldering agent in insulated wires and cables
6b. Nonylphenol ethoxylates (NPE) NPE degrades to NP	- Use as stabiliser and emulsifying agent in paints, varnishes and coatings (main use and risk use) - Use as solvent for pesticides applied in agriculture and horticulture (high emission factor to wastewater) - Use as aid agent in pre-treatment of wooden fibre mass and removal of lignin in manufacture of pulp (high emission factor to wastewater) - Use as stabiliser and developer agent in developing photos (high emission factor to wastewater) - Use in metal-working fluids in treatment and coating of metal (high emission factor to wastewater) - Use as surface-active agent in manufacture of pharmaceuticals - Use as cleaning agent in cleaning preparations applied by industry and households (main use and high emission factor to wastewater) - Use as soldering agent in manufacture of electronic valves and tubes and other electronic components - Use as laboratory chemical - Use as anti-icing agent in aircraft (high emission factor to wastewater) - Use in liquids designed for technical testing on damage / cracks in different objects - Use in cosmetics - Use as surface-active agent in veterinary medicines - Use in treatment of textiles (e.g. washing of wool, pre-treatment of fibres and smoothing of ink / colour) (main use and high emission factor to wastewater)

	- Use as degreasing agent in treatment of animal hides (main use and high emission factor to wastewater) - Use in concrete in order to increase its porosity (high emission factor to wastewater)
7a. Octylphenols (OP)	- Use as adhesive during vulcanisation in manufacture of car tyres - Use in paper coating - Use in insulation of electronic coils in manufacture of electric motors, generators and transformers - As impurity in nonylphenol at concentrations of 1-10%
7b. Octylphenol ethoxylates (OPE) OPE degrades to OP	- Use as stabiliser and developer in developing photos - Use as surface-active agent in cleaning preparations used e.g. in service of motor vehicles, compressors and other industrial cleaning - Use as adhesive and glue in manufacture of plastic products - Use in water-based metal-working fluids in treatment and coating of metal - Use as emulsifier and dispersant for pesticides applied in agriculture and horticulture - Use in treatment of textiles and leather finishing - Use as emulsifier in manufacture of styrene-butadiene polymers - Use as emulsifier and dispersant in water-based paints, printing inks and paints intended for surfaces exposed to sea water - Use in pharmaceuticals
8a. Short-chain chlorinated paraffins (SCCP or chloroalkanes, C_{10-13})	- Use in manufacture of textiles and wearing apparels in order to achieve clothes (designed e.g. for sailing and industrial work) of high flame-resistant, water-proof and anti-fungal properties - Use as greasing agent in leather finishing, further use in manufacture of leather products - Use in metal-working fluids (both water- and oil-based) in treatment and coating of metal - Use as lubricants in compressed air tools in garages and in different industrial sectors - Use as plasticiser and flame retardant in paints (used e.g. in road marking and as primer for surfaces exposed to sea water), varnishes and coatings - Use as plasticiser and flame retardant in rubber products such as gaskets, sealants and in glues which have been used e.g. in construction sector and car industry - MCCP can contain up to 1% SCCP
8b. Medium-chain chlorinated paraffins (MCCP or chloroalkanes, C_{14-17})	- Use as substitute for SCCP - Use as greasing agent in leather finishing - Use in metal-working fluids (both water- and oil-based) in treatment and coating of metals - Use as plasticiser and flame retardant in paints (used e.g. in road marking and as primer for surfaces exposed to sea water), varnishes and coatings - Use as plasticiser and flame retardant in rubber products such as gaskets and in glues which have been used e.g. in construction sector and car industry - Use in some carbon copy paper types - Use as plasticiser and flame retardant in PVC plastic and further use in manufacture of plastic products
9. Endosulfan	- Agricultural pesticide (main use) - Possible use as a wood impregnation agent
Heavy metals	
10. Mercury Chosen as indicator for objective 1 and objective 2	Dentistry (dental amalgams) Batteries Measuring and control instruments (e.g. thermometers) Lamps Electronics Laboratory chemical and pharmaceuticals Gold and silver recovery Chlor-alkali industry Coating on paper or film in photographic applications Fossil fuel combustion in power plants Crematoria Production of zinc and copper (Hg in raw material) Non-antifouling paints (use possible)

	Cosmetics Pesticide Marine antifouling paints Wood preservation Textile treatment
11. Cadmium Chosen as indicator for objective 1 and objective 2	Stabiliser for PVC Pigment in plastics, glasses, ceramics, paints, papers and inks Electrode material in nickel-cadmium batteries Synthesis of other inorganic cadmium compounds Metal industry and metal ore roasting or sintering installations Production of ferrous and non-ferrous metals (zinc mining, lead and zinc refining, cadmium) Plating of metals i.e. protection of iron against corrosion Component for various alloys Solar cells Fossil fuel combustion in power plants Fertiliser

Ecological objectives for hazardous substances will be measured where applicable by the following initial indicators and targets:

Table 1. Indicators for ecological objectives **"**Concentrations of hazardous substances close to natural levels" & "All fish safe to eat"

Indicator substance and matrix	**Target**
Ecological objective "Concentrations of hazardous substances close to natural levels" (i.e., environmental monitoring)	
Cadmium * in fish (herring or flounder or perch) liver as indicator for different sub-regions of Baltic Sea and * in bivalve (blue mussel or Baltic clam) soft tissue as indicator for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Ultimate target level to reach near background concentrations
Mercury * in fish (herring or flounder or perch) muscle as indicators for different sub-regions of Baltic Sea and * in bivalve (blue mussel or Baltic clam) soft tissue as indicators for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Intermediate target level for fish in **Table 2** Ultimate target level to reach near background concentrations
Dioxins, furans, dioxin-like PCBs * in fish (herring or salmon or perch) muscle for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Intermediate target level for fish in **Table 2** Ultimate target level to reach close to zero concentrations
TBT * in sediment or biota (fish or mussel) or imposex (i.e., biological effects monitoring) for different sub-regions of Baltic Sea	Primary target decreasing concentration trend and/or decreasing effects. Ultimate target level to reach close to zero concentration and/or no effect level.
PFOS * in sediment or fish (species optional) liver for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Ultimate target level to reach close to zero concentrations
Ecological objective "All fish safe to eat" (i.e., human health monitoring)	
Cadmium * in fish (herring or flounder or perch) muscle / edible part as indicators for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Intermediate target level for fish in **Table 2** Ultimate target level to reach near background concentrations
Mercury * in fish (herring or flounder or perch) muscle / edible part as indicators for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Intermediate target level for fish in **Table 2** Ultimate target level to reach near background concentrations
Dioxins, furans, dioxin-like PCBs * in fish (herring or salmon or perch) muscle / edible part for different sub-regions of Baltic Sea	Primary target of decreasing concentration trend Intermediate target level for fish in **Table 2** Ultimate target level to reach close to zero concentrations

Table 2. Intermediate target levels / maximum allowable concentrations of mercury (Hg), cadmium (Cd), dioxins and sum of dioxins & dioxin-like PCBs in fish muscle meant for foodstuff as regulated by EC 1881/2006	
Substance	**Maximum levels in fish muscle** (µg/kg WW fish). Note: that exceptions in parentheses include only eel and pike, other species named in the regulation but less common in the Baltic are excluded.
Hg	500 (1,000 in pike *Esox lucius*, eel *Anguilla anguilla*)
Cd	50 (100 in eel *Anguilla anguilla*)
Dioxins (WHO-PCDD/F-TEQ)	4×10^{-3}
Dioxins + dioxin-like PCBs (WHO-PCDD/F-PCB-TEQ)	8×10^{-3} (**12×10^{-3} in eel *Anguilla anguilla***)

Table 3. Indicators for ecological objective "Healthy wildlife"	
Indicator	**Target**
Predatory bird health: White tailed sea eagle (and/or osprey) for different sub-regions of Baltic Sea * Proportion of successfully reproducing pairs * Mean brood size	targets need to be defined
Fish health: * Fish Disease Index	target needs to be defined
Seal health: Grey seal for entire Baltic and ringed seal for northern Baltic, also harbour porpoise proposed for the consideration of Seal Group - rate of pregnancy (CA) - rate of fecundity (CL) - occurrence of uterine pathology (occlusion, stenosis, "myoma") - occurrence of intestinal ulcers in 1-3 year-old seals	- normal pregnancy rate (to be defined) - normal fecundity rate (to be defined) - normal level of uterine pathology (to be defined) - normal occurrence of intestinal ulcers in 1-3 year-old seals

Table 4. Indicators for ecological objective "Radioactivity at pre-Chernobyl levels" Target levels have been calculated on basis of average concentrations during years 1984-85 which refer to pre-Chernobyl time period.	
Indicator substance and matrix	**Target**
Cs-137 * in herring muscle as indicator for whole Baltic Sea * in plaice and flounder muscle for Southern Baltic Sea (southwards from Gotland)	- Primary target of decreasing concentration trend - Ultimate target level to reach pre-Chernobyl level which is 2.5 Bq/kg wet weight for herring muscle and 2.9 Bq/kg wet weight for plaice and flounder muscle
Cs-137 * in sea water for whole Baltic Sea	- Primary target of decreasing concentration trend - Ultimate target level to reach pre-Chernobyl level of 14.6 Bq/m^3
Cs-137 * in sediment for whole Baltic Sea	- Primary target of decreasing concentration trend - Ultimate target level to reach pre-Chernobyl level 1 640 Bq/m^2

Nature conservation and biodiversity

Ecological objectives for nature conservation and biodiversity will be measured by the following initial indicators and targets:

Natural marine and coastal landscapes

Targets:

- By 2010 to have an ecologically coherent and well-managed network of Baltic Sea Protected Areas (BSPAs), Natura 2000 areas and Emerald sites in the Baltic Sea,
- By 2012 to have common broad-scale spatial planning principles for protecting the marine environment and reconciling various interests concerning sustainable use of coastal and offshore areas, including the Coastal Strip as defined in HELCOM Rec. 15/1,
- By 2021 to ensure that “natural” and near-natural marine landscapes are adequately protected and the degraded areas will be restored.

Preliminary indicators:

- Designated BSPAs, Natura 2000 and Emerald site area as percentage of total sub-region area,
- Percentage of important migration and wintering areas for birds within the Baltic Sea area which are covered by the BSPAs, Natura 2000 and Emerald sites,
- Percentage of marine and coastal landscapes in good ecological and favourable status,
- Percentage of endangered and threatened habitats/biotopes’ surface covered by the BSPAs in comparison to their distribution in the Baltic Sea,
- Trends in spatial distributions of habitats within the Baltic Sea regions.

Thriving and balanced communities of plants and animals

Targets:

- By 2021, that the spatial distribution, abundance and quality of the characteristic habitat-forming species, specific for each Baltic Sea sub-region, extends close to its natural range,
- By 2010 to halt the degradation of threatened and/or declining marine biotopes/habitats in the Baltic Sea, and by 2021 to ensure that threatened and/or declining marine biotopes/habitats in the Baltic Sea have largely recovered,
- To prevent adverse alterations of the ecosystem by minimising, to the extent possible, new introductions of non-indigenous species.

Preliminary indicators:

- Percentage of all potentially suitable substrates covered by characteristic and healthy habitat-forming species such as bladderwrack, eelgrass, blue mussel and stoneworts,
- Trends in abundance and distribution of rare, threatened and/or declining marine and coastal biotopes/habitats included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area,
- Trends in trophic structure and diversity of species (e.g. caught in scientific surveys),
- Trends in the numbers of detections of non-indigenous aquatic organisms introduced into the Baltic Sea.

Viable populations of species

Targets:

- By 2021 all elements of the marine food webs, to the extend that they are known, occur at natural and robust abundance and diversity,

- By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species,
- By 2012 spatial/temporal and permanent closures of fisheries of sufficient size/duration are established thorough the Baltic Sea area,
- By 2009, appropriate breeding and restocking activities for salmon and sea trout are developed and applied and therefore genetic variability of these species is ensured,
- By 2009 illegal, unregulated and unreported fisheries are close to zero,
- By 2008 successful eel migration from the Baltic Sea catchment area to the spawning grounds is ensured and national programmes for conservation of eel stocks are implemented,
- By 2015, as the short-term goal, to reach production of wild salmon at least 80%, or 50% for some very weak salmon river populations, of the best estimate of potential production, and within safe genetic limits, based on an inventory and classification of Baltic salmon rivers,
- By 2015, to achieve viable Baltic cod populations in their natural distribution area in Baltic proper,
- By 2015, to have the re-introduction programme for Baltic sturgeon in place, and - as a long term goal, after their successful re-introduction has been attained - to have best natural reproduction, and populations within safe genetic limits in each potential river,
- By 2015 by-catch of harbour porpoise, seals, water birds and non-target fish species has been significantly reduced with the aim to reach by-catch rates close to zero,
- By 2015 discards of fish are close to zero (<1%).

Preliminary indicators:

- Trends in the number of threatened and/or declining species,
- Abundance, trends and distribution of Baltic seal species compared to the safe biological limit (limit reference level) as defined by HELCOM HABITAT,
- Abundance, trends, and distribution of Baltic harbour porpoise,
- Number of rivers with viable populations of Baltic sturgeon,
- Spawning stock biomass of western Baltic cod and eastern Baltic cod compared to precautionary level (Bpa) as advised by ICES and/or defined by EC management plans,
- Fishing mortality level of western Baltic cod and eastern Baltic cod, compared to precautionary level (Fpa) as advised by ICES and/or defined by EC management plans,
- Trends in numbers of discards and by-catch of fish, marine mammals and water birds,
- Number of entangled and drowned marine mammals and water birds,
- Number of salmon rivers with viable stocks,
- Trends of salmon smolt production in wild salmon rivers.

Maritime Activities

Management objectives for maritime activities will be measured by the following initial indicators and targets:

Enforcement of international regulations - No illegal pollution

- Number of surveyed/inspected ships found to use organotin compounds actively in their antifouling systems in relation to the total number of surveyed ships calling at Baltic Sea ports,
- Pollution per Flight Hour (PF) Index (ratio of total no. of detected oil spills to total no. of flight hours) per year,
- Number of detected/confirmed illegal oil discharges per year,

- Number of regular flight hours, including Co-ordinated Extended Pollution Control Operation (CEPCO) flights, per year,
- Number of satellite imageries per year per sub-region,
- Number of ships caught red-handed per year,
- Amount of ship-generated waste delivered to port reception facilities in the Baltic ports in relation to the total number of calls at ports,
- Number of notifications on inadequacy of port reception facilities received by the Contracting States.

Safe maritime traffic without accidental pollution*

- Number of shipping accidents, including in ice conditions, per year in relation to yearly traffic (number of ships crossing pre-defined AIS lines),
- Number of accidents with pollution in relation to the total number of accidents per year,
- Number of collisions/groundings in relation to the total number of accidents per year.

Efficient emergency and response capability

General evaluation of implementation by HELCOM RESPONSE

- Rate of oil recovery and the amount of oily wastes at sea and on the shoreline during response operations to oil accidents,
- Number of accidents where dispersants were used.

Minimum sewage pollution from ships

- Number of ferry and passenger terminals equipped with adequate sewage reception facilities per number of all ferry and passenger terminals in a country per year,
- Number of ferries and passenger ships delivering sewage to port reception facilities.

No introductions of alien species from ships

General evaluation of implementation by HELCOM MARITIME in co-operation with HELCOM MONAS and HELCOM HABITAT

- Number of new introductions observed per year,
- Number of established alien species per year,
- Amount of sediments delivered to port reception facilities.

Minimum air pollution from ships

- NOx emissions from shipping in the Baltic per year,
- Number of ships that use NOx abatement technology and specified by technology, such as SCR (selective catalytic reduction), HAM (Humid Air Motor Technique), water injection, etc.,
- Number of non-compliant ships in relation to the total number of ships inspected in the Baltic Sea ports to control compliance with fuel oil requirements of Annex VI to MARPOL 73/78,
- Average content of sulphur in fuel delivered to ships from fuel oil suppliers in the Baltic Sea per year.

Zero discharges from offshore platforms

General evaluation by HELCOM MARITIME.

Minimum threats from offshore installations

General evaluation by HELCOM MARITIME.

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* *applicable for tankers over 150 GT and other ships over 400 GT according to the agreed HELCOM reporting form*

Examples of measures for reducing phosphorus and nitrogen losses from agriculture

Land use

Converting arable land to extensive grassland

Changing from intensive agriculture to extensive grassland will reduce nitrogen and phosphorus losses. This method suits best in areas which were historically kept as grazing areas and have conservation value.

Effectiveness

Converting arable land to extensive grassland is very effective in reducing nitrogen because the low inputs ensure that nitrogen does not accumulate in soil. Conversion to ungrazed grassland can reduce nitrate losses by 95%. However, where the phosphorus content in soil is high, significant reductions in the leaching of soluble phosphorus are not achieved in the short term because the elevated levels of phosphorus will continue to be recycled through the soil. The immediate effect is that a permanent vegetative cover will reduce soil erosion and phosphorus losses in surface runoff. Conversion to ungrazed grassland can result in a 50% reduction in phosphorus.

Costs

This is an extreme change in land use that is unlikely to be implemented by farmers without incentives.

Soil management

Plant cover in winter

Plant cover in winter will reduce nitrogen and phosphorus leaching and soil erosion.

Effectiveness

Without the plant cover in winter, nitrate can be lost through leaching by excess winter rainfall and phosphorus through sediment transport in surface runoff. Plant cover in winter protects the topsoil of the fields against the erosive forces of rain, melt and runoff waters during winter. Furthermore, it helps to improve the soil structure by increasing the amount of organic matter in the topsoil of the fields which decreases the topsoil's susceptibility to silting. Plant cover in winter can reduce erosion 10-40% and nitrate leaching 10-70%.

Costs

The method is relatively easy to implement. The costs of this method depend on the chosen plant, area and the possibility to use the farmer's own machinery or contractor.

Minimal cultivation systems

Using discs or tines to cultivate the soil or direct drill into stubbles (no-till) will maintain organic matter and preserve good soil structure. This will improve infiltration and retention of water and thereby decrease total phosphorus concentrations in surface runoff.

Effectiveness

Conversion from ploughing to minimal or no cultivation systems will decrease phosphorus in surface runoff. When using minimal cultivation systems the phosphorus storage concentrates in the shallow topsoil and that can in the long term increase the amount of dissolved phosphorus especially on the steep slopes with high phosphorus content. Buffer zones and more accurate phosphorus fertilisation should be used there. Nitrate leaching is generally decreased to a small extent through reduced mineralisation of organic matter in soil in the autumn.

Costs

The costs of this method depend on how it suits to the farm's crop rotation, how suitable the soils are for this method and whether it is profitable to use a contractor or purchase the machinery for the farm.

Cultivate land for crop establishment in spring rather than autumn

Autumn cultivation of land stimulates the mineralisation of nitrogen from organic matter reserves at a time when there is little nitrogen uptake by the crop, which will increase the potential for over-winter leaching losses. By cultivating in spring, there will be less opportunity for mineralised nitrogen to be leached and the nitrogen will be available for uptake by the established spring crops.

Effectiveness

Cultivation of soils results in mineralisation of organic nitrogen and increases the risk of nitrate leaching. The amount of mineralisation is strongly affected by soil temperature, moisture and nitrogen balance under the previous crop. Cultivation in spring is better, because bare soil is not exposed over the winter period and actively growing crop is established soon after cultivation to take up nitrogen and provide surface cover.

Costs

Land for spring crops, ploughed late in the autumn, has the winter for frost action and wetting and drying cycles to break down soil clods. Ploughing in the autumn also allows early establishment of the following spring crop. On medium to heavy soils if ploughing is not carried out in late autumn, the delayed cultivation may result in the spring crop being drilled into a drying seedbed. This may impact on establishment and yield.

Catch crops

Catch crops are fast-growing crops that are grown simultaneously with or between successive plantings of a main crop.

Effectiveness

Catch crops protect the surface of the soil and catch the extra nutrients. The longer the soil is covered with vegetation, the smaller is the nitrate leaching. Catch crops can also improve the soil structure and increase the amount of organic matter in the soil. According to a Finnish study undersowing of ryegrass with barley reduced nitrate leaching 27-68% depending on soil.

Costs

This method is relatively easy to implement. The costs of this method consist of buying the seeds, sowing and finishing the catch crop.

Ploughing of ley on sandy soils in autumn

The time for ploughing a ley is very important to nitrogen leaching. From a leaching point of view, it should be ploughed late in autumn instead of early in autumn. Spring ploughing is also good but nitrogen release from the large amounts of organic-N is often too late for crop demand and might instead be leached in the following autumn. However, ploughing in late autumn or in spring is not possible on many clay soils so this is a method for sandy soils.

Effectiveness

Because a lot of organic nitrogen is turned over into nitrate when ploughing a ley, leaching from ley ploughed early in autumn can be considerable, especially if the ley contains clover or if there is a lot of above-ground biomass. In such cases, an effective way to reduce leaching is to delay the ploughing of ley from early to late autumn. On clay soils effectiveness decreases as the clay content in the soil increases up to a limit where the clay content does not make it possible to employ late ploughing or ploughing in spring.

Costs

The single largest cost arises if ploughing is done so late in autumn that sowing of winterwheat is no longer possible. Ley is a good crop before winterwheat and often gives a larger yield of winterwheat compared to when cereals are cultivated before winterwheat. If this situation occurs, costs can be of importance but if the timing of ploughing of ley does not influence the choice of the next crop in the crop-rotation the cost is small.

Controlled sub-surface drainage

Controlled sub-surface drainage intensifies the drainage systems so that drainage waters from the arable areas can be efficiently utilised by the plants. The runoff of drainage waters is controlled and they are recirculated back to the arable area for irrigation.

Effectiveness

Controlled subsurface drainage will prevent nutrient leaching with ditch waters from the arable areas into watercourses and return the nutrients dissolved in the water back to the plants' root zone. Controlled subsurface drainage can result in 40% nitrate reduction.

Costs

The cost will be covered best in the cultivation of special plants e.g. potato.

Fertiliser and manure management

Nutrient balances

Preparing nutrient balances provides farmers with a tool for the long-term planning of fertilisation. Nutrient balances provide information on the efficiency of nutrient utilisation and help to identify the cropping phases in which nutrients are lost. The calculation of nutrient balances makes it possible to intensify the water protection measures for each farm and parcel.

Effectiveness

Using nutrient balances for fertilisation planning helps to reduce the excess nutrients in the soil to a minimum. It also ensures that the soil is in a sufficiently fertile state to maximise the efficient use of nutrients already in the soil. Improving the accuracy of the use of fertilisers on the basis of the crop, the yield and the characteristics of the parcel to the economic optimum will ensure that the necessary quantities of the essential crop nutrients are only available when required for uptake by the crop.

Costs

This method is cost-effective. Nutrient losses are a direct measure of the principal problem, namely excessive nutrients in the environment. Farmers have the freedom to determine the most economical method of nutrient loss reduction. The use of this method will require investment in education and guidance.

Conversion from conventional to organic production

Minimum standards of organic production are regulated by Council Regulation (EEC) No. 834/2007 and starting by 1 January 2009 Council Regulation (EEC) No. 2092/91.

Effectiveness

Nutrient input in organic production aims at promoting and maintaining soil fertility rather than crop yield. Organic production aims at closed nutrient cycles. Nutrient use efficiency is regularly higher and nutrient losses to the environment lower than in conventional production.

Costs

Organic production systems often use more labour because of new management practices, manual control of weeds, pests, and diseases and applying large volumes of organic fertilisers. They also have potentially increased harvest costs. The combined effect on production costs from increased labour requirements and lower chemical inputs will vary and must be assessed in relation to other factors, particularly yield and price changes.

Reduced fertilisation

Reducing the amounts of nitrogen and phosphorus fertilisers by a certain percentage below the economic optimum will reduce the residual nitrate in the soil after harvest and in the short term the amount of soluble phosphorus. In the long term reducing phosphorus fertilisers can reduce the amount lost as particulate phosphorus.

Effectiveness

There will be a reduction of residual soil nitrate available for leaching in the autumn but there will be no effect on the nitrate mineralised from soil organic matter. In the long run, when soil phosphorus reserves will be decreased there will be a reduction in soluble phosphorus loss.

Costs

This method will have an impact on crop yields and crop quality and therefore there would be a considerable resistance to the method. Reducing phosphorus fertilisers would impact immediately crops that are particularly responsive to phosphorus e.g. potatoes and some vegetable crops. Reduction of nitrate fertilisers would have an immediate impact on all crops other than legumes.

Application techniques of manure

Decreasing of manure surface application and promoting injection techniques and mulching will decrease leaching into the watercourses immediately. These methods will help to prevent the exposure of manure to the surface runoff and drain flow losses.

Effectiveness

By injecting the slurry it is possible to apply it directly into the active layer of soil. The slurry can be released into slots cut in the soil and then closing them after application. There are also direct ground injection systems in operation which work by the direct injection of pressurised slurry into the ground. The injection of slurry effectively increases the utilisation of manure nutrients compared with surface application.

Costs

The additional cost is the biggest in the small farms. In the big farms the fixed costs will be divided by a bigger amount of manure and additional costs per tonne are smaller.

Integration of fertiliser and manure nutrient supply

Using manure analysis to calculate the amount of nutrients supplied by manure applications will help to determine the amount and ideal timing of additional fertilisers required by the crop. Taking better account of the nutrients in manure can reduce the fertiliser inputs and nitrate and phosphorus losses.

Effectiveness

Mineral fertiliser applications are reduced for optimum economic production level and to maintain adequate levels in the soils. The method is effective when mineral fertilisers are used to top-up the nutrients supplied in manure.

Costs

This method achieves savings rather than increasing costs. The use of this method will require investment in education and guidance.

Liming

Acid soil makes the plant nutrient uptake difficult. Especially the applicability of phosphorus is weakened in the acid soils. Phosphorus is bound tightly to the soil particles and it will easily drift from the fields with runoff waters to the watercourses. Phosphorus intake will increase considerably when the pH is over 6.0.

Effectiveness

Liming helps to attain reasonable yields in acid soils with lower phosphorus fertiliser rates. Liming aims to ensure that phosphorus is utilised efficiently and thus to prevent nutrients from leaching into watercourses.

Costs

It may take 5 to 10 years after application to recover the cost of lime. The economics of lime use on rented land need special consideration. Profitability of liming on rented land is decreased and depends on the period of the rental agreement.

Avoiding the application of fertilisers and manure to high-risk areas

Not applying mineral fertilisers and manure at any time to high-risk areas helps to prevent the mobilisation and transfer of nitrate and phosphorus to the watercourses. Risk areas can be, for example, areas with flushes draining to a nearby watercourse, cracked soils over field drains or fields with high phosphorus values. Phosphorus risk areas can be estimated by using the phosphorus risk index or certain specified risk elements.

Effectiveness

Losses of phosphorus on eroded soil particles and by leaching are greatest on high phosphorus index soils. Applying manure to these areas will increase the excessive phosphorus content of the soil and increase the amounts lost. This method is most effective against losses of phosphorus where the primary mechanism of transport is surface runoff.

Costs

The cost of not applying fertilisers to high-risk areas would be in terms of avoiding a drop in production proportional to the lost yield. Not applying manure to high-risk areas will have no costs if land is available elsewhere on the farm. If there is a need for increased manure storage, there would be additional costs.

Avoiding the spreading of fertilisers and manure during high-risk periods

Avoiding spreading mineral fertilisers or manure during high-risk periods reduces the availability of nitrate for loss through leaching and of phosphorus for loss in surface runoff. High-risk periods can be, for example, when there is a high risk of surface flow, rapid movement to field drains from wet soils or when there is little or no crop uptake.

Effectiveness

Surface runoff risk is the greatest when rain falls onto sloping ground with saturated, frozen or snow-covered soils. Rapid flow of nutrients through the soil is most likely to occur from drained soils when they are wet and rainfall follows soon after applying fertilisers. Avoiding the addition of nitrogen in the autumn reduces the amount of nitrates available for leaching by over-winter rainfall.

Costs

This method will not have any costs in most cases because the fertiliser should not be required during high-risk periods since the crop will not be growing. However there may be indirect opportunity cost if the high-risk periods coincide with crop development in spring.

Increasing the capacity of manure storage

Adequate collection and storage facilities provide the possibility to choose when to apply manure to fields and there will be fewer occasions when lack of capacity forces the farmer to spread manure at unsuitable times. Manure can be spread at times when there is a low risk of runoff and when there is an actively growing crop to utilise the nutrients supplied in the manure.

Effectiveness

If there is not enough storage capacity for manure the farmer has to spread it as it is produced. This will inevitably result in applications at times when there is a risk of nitrate leaching and phosphorus being transported to watercourses in surface runoff.

Costs

This method is most important on farms that handle their manure as slurry.

Transporting manure to neighbouring farms

Where there is a surplus of nutrients, farm manure can be exported to neighbouring farmland. This reduces the nutrient load on the farm that has an excess of manure thereby reducing the risk of diffuse pollution. It also enables the remaining manure to be managed in a more integrated way.

Effectiveness

It is possible to balance the input of nutrients in an effective way so that there will be enough capacity of land to absorb the nutrients.

Costs

This method is most easily applied when the receiving farm holding is close e.g. within 5-20 km. The costs increase with distance. The treatment of manure (composting) helps it to be transported over larger distances relatively easily.

Slurry separation

In slurry separation, slurry is divided into a liquid and a solid fraction. The liquid part with lower nutrient concentration can be utilised at the production site and the solid with high dry matter content and high nutrient concentration can be transported to the other farms. This can either be done slowly by a weeping-wall system, or more quickly by mechanical separation. There are a number of different types of mechanical separators including rotary screens, roller presses, screw presses, inclined screens and vibrating screens.

Effectiveness

Slurry separation does not change the total phosphorus content of the slurry but will help to decrease the cost of transportation to other areas when there is not enough arable land to spread the slurry. Slurry separation allows greater flexibility in spreading times and application and thus can optimise the full nutrient potential of slurry.

Costs

In order to get maximum return from the investment, a separator must integrate easily into the existing farm setup with little extra expense and there must be sufficient slurry produced on the farm to justify the outlay.

Composting solid manure

Composting uses aerobic microbial metabolism to increase temperatures to inactivate pathogens and to reduce the readily available nitrate content of manures. Composting results in a more stable product which is easier to spread and more attractive to distribute to greater distances.

Effectiveness

The readily available nitrate content of manure is typically reduced from 25% to 10% of the total nitrates, so nitrate losses in land spreading are likely to be lower.

Costs

Composting of solid manures can be carried out on individual farms using standard farm equipment.

Biogas production

Biogas production reduces greenhouse gas emissions, provides a source of renewable energy and generates a digest product with reduced odour emissions and pathogen content at land spreading.

Effectiveness

Biogas production does not change the total nutrient content of the manure but will help to distribute it to greater distances through improved transport economy. The biogas digest is more easily distributed over a greater distance than the slurry.

Costs

High capital costs discourage uptake unless the process is supported by economic incentives or subsidies. The biogas production that is completely based on farm manure production can only be profitable in very large scale. Small farms can get the biogas production to be profitable by handling waste materials that come outside the farm or selling energy or biogas digest or if the energy consumption on a farm is very big.

Pelletisation

Pelletisation is most appropriate for manures with a high dry matter content, such as poultry litter or manures that have already been treated and separated to give a high dry matter material.

Effectiveness

Pelletisation does not change the total nutrient content of the manure but will help to distribute it to greater distances through improved transport economy.

Costs

Pelletisation is generally carried out in centralised plants. The costs are high but the end product can command a good price as a fertiliser.

Incineration

The incineration process has been identified as one possible method for dealing with poultry litter. The poultry litter is used as a fuel for power plants. The resulting ash can be sold as a phosphate and potash fertiliser.

Effectiveness

Incineration does not change the total nutrient content of the manure but will help to distribute it to greater distances through improved transport economy.

Costs

The investment costs are high. The running costs of incineration are estimated at around one Euro per tonne of dry solids contained in the waste. Although poultry manure is very dry and readily combustible, it may not be economically feasible to establish an incineration plant solely for solid farm wastes and even more so for slurries owing to the large amount of water present.

Animal feeding

Adopting phase feeding of livestock

Livestock at different growth stages or stages of the reproductive cycle have different optimum nutritional requirements. Because of limited labour and housing facilities, livestock with different feed requirements are often grouped together and receive the same ration. As a result some stock will receive higher levels of nitrogen and phosphorus than they can utilise efficiently and will excrete the surplus.

Effectiveness

Greater division and grouping of livestock on the basis of their feed requirements allows more precise formulation of individual rations. This will reduce the amount of nitrogen and phosphorus applied in manures and therefore decrease losses in surface runoff and by leaching.

Costs

There is a limited scope for improvements in the poultry sector where phase feeding is already widely in use. There is a great potential for phase feeding in the pig sector to reduce nitrogen and phosphorus excretion. However the costs can be considerable without necessarily improving performance.

Reducing dietary nitrogen and phosphorus intakes

Farm animals are often fed diets with higher than recommended contents of nitrogen and phosphorus as a safeguard against a loss of production arising from a deficit of these nutrients. For example, it has been shown that some cows get more protein (nitrogen) in their feed than would be necessary. In practice, however, surplus nitrogen and phosphorus is not utilised by the animal and will be excreted.

Effectiveness

Avoiding excess nitrogen and phosphorus in the diet composition of livestock diets can reduce the amount of nitrogen and phosphorus excreted either directly to fields or via manure and thereby minimise additions to the pools of nitrogen and phosphorus that are sources of diffuse pollution.

Costs

For example, the protein content in cowfeed can be reduced by one percent unit without decreasing milk yield.

Phytase supplementation

Supplementation of synthetic phytase to pig feed reduces the need for the addition of mineral phosphate. Phytase increases the availability of phosphorus in the feed and allows total phosphorus contents to be reduced without affecting productivity.

Effectiveness

With the addition of phytase the phosphorus content of the feed can be reduced by up to 30% for pig feed.

Costs

If there is too little phosphorus in the pig feed or the ratio between different minerals is wrong, the condition of pig legs and the ability to move can weaken. This can have an effect on the economic output.

Wet feed and fermentation

Endogenous phytase in grain can be activated by wetting the pig feed some time before feeding thereby reducing or even eliminating the need for mineral phosphorus supplementation. This means that pig production with wet feed systems should be able to utilise feed with lower phosphorus content than normally recommended.

Fermentation of the feed can reduce the need for mineral phosphate supplementation. Fermentation occurs naturally in wet feed after a certain amount of time. The fermentation process is difficult to manage and the method is still to be developed.

Farm infrastructure

Establishment of wetlands

Constructed or established wetlands are used to intercept runoff water from a field or group of fields. Wetlands can be natural or artificial, permanent or temporary, with water that is static or flowing, fresh or brackish. The wetland may be a wet grassland, wet woodland, reed bed, bog, sedimentation pond or lake.

Effectiveness

Wetlands act by intercepting pollutant delivery, providing a buffer zone and can potentially clean up polluted water. Wetlands improve water quality by breaking down, removing, using or retaining nutrients, organic waste and sediment carried to the wetland with runoff from the watershed. They can trap sediment and through the retention of runoff reduce nitrates and phosphorus (soluble and particulate). Wetlands reduce the severity of floods downstream by retaining water and releasing it during drier periods and protect stream banks and shorelines from erosion. According to a Finnish study, wetlands have reduced 25-48% phosphorus and 20-90% nitrogen. Swedish studies show that wetlands can reduce phosphorus 90-100% and nitrates 76-90%. The effectiveness depends on the size of the wetland, vegetation, loading and influx.

Costs

Wetlands are quite expensive to implement and their construction will often involve the loss of some agricultural land. Constructed wetlands require maintenance due to deposition of sediment and organic matter.

Buffer zones

Establishing vegetated and unfertilised buffer zones alongside watercourses decreases erosion and the movement of nutrients into watercourses. Buffer zones can reduce pollution in two ways. They stop agricultural activity on the area and therefore reduce direct pollution from inorganic fertilisers and organic manure additions. They also intercept overland flow from agricultural areas just before it reaches the watercourse.

Effectiveness

Buffer zones should be free-draining and have a good surface porosity to intercept surface runoff. According to a Finnish study, buffer zones of 10 meters have proved to be efficient in reducing the leaching of suspended solids, dissolved phosphorus and total nitrogen. During the four years of research, suspended-solid loads were reduced by 50–60%, leaching of nitrogen by 50% and leaching of phosphorus by 30%. The efficiency of buffer zones in removing suspended solids and nutrients is affected by the width of the zone, gradient of the drained field, soil type and particularly by the variety and density of zone vegetation.

Costs

Buffer zones require a certain amount of investment to establishment but once established require little maintenance.

Other

Effective purification of runoff waters

For the purification of runoff waters, soil particles in the runoff water are precipitated by Al^{3+} -ions or aluminium oxide polymers resulting in a low concentration of soluble phosphorus in runoff waters and negligible amounts of exchangeable phosphorus in the precipitated soil aggregates. This method needs further refinement and testing if it is to be used for quantitative determination of redox-sensitive P in runoff.

Systematic on-farm individual advice

Agrotechnical measures are implemented by close co-operation between farmers and advisors. Advisors apply limited stocking density, crop coverage over winter, intercropping, fixed value for nitrogen utilisation of farm manure, limited nutrient budget, fertiliser plans and nutrient balances.

Effectiveness

This method can reduce nutrient input by 50% and nutrient losses by 30%.

Costs

The method is easy to implement. It requires a dense system of advisors to support farmers.

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Road map towards harmonised implementation and ratification of the 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments

We agree to ratify the 2004 International Convention for Control and Management of Ships' Ballast Water and Sediments (BWM Convention) as soon as possible, but in all cases not later than 2013. To this end WE AGREE:

1. To designate/identify clear national responsibilities for coordinating the national implementation of the BWM Convention.
2. To request HELCOM HABITAT and HELCOM MONAS to compile, from the existing data sources, by **the end of 2008** a HELCOM list of non-indigenous, cryptogenic and/or harmful native species in the Baltic Sea, including available information on their characteristics, distribution, abundance and ecological impact, and to keep the list updated as new knowledge becomes available.
3. To establish co-operation with other relevant regions for continuous exchange of information on non-indigenous, cryptogenic and harmful native species in other aquatic environments, including high risk invaders, and to make this information available for risk assessments.
4. Based on the HELCOM list and available information on potentially harmful and invasive species in other aquatic ecosystems, to select and agree by **the end of 2008** on the HELCOM Target Species, i.e. species that may impair or damage the environment, human health, property or resources in the Baltic Sea region, relevant for risk assessments according to the IMO Guidelines G7.
5. To conduct by **the end of 2008** baseline surveys of prevailing environmental conditions in major ports and to outline the major long-distance high risk voyages in order to gather data necessary to conduct and/or evaluate and consult risk assessments according to the IMO Guidelines G7.
6. To specify and agree **as soon as possible but not later than 2009** on criteria to distinguish between unacceptable high risk scenarios and acceptable low risk scenarios for regional voyages, i.e. voyages within the Baltic Sea biogeographical region, taking into account the relevant IMO Guidelines and data gathered under points 2-5, in order to support transparent and consistent risk assessments and to arrive at a unified Baltic Sea exemption system according to Regulation A-4 of the Annex to the BWM Convention.
7. For regional voyages connecting specified ports or locations assessed as posing an unacceptable high risk (regional high risk voyages), and therefore for which the exemption could not be granted according to the BWM Convention, to arrange in advance for suitable management options, which may include designation of ballast water exchange (BWE) zones, and if the case, agree on the general recommendations for such exchange in BWE zones. BWE zones, if at all, would only be of use for regional voyages/ships identified to represent a high risk. The possible management options should only be valid until the D-2 Performance Standard of the BWM Convention becomes obligatory.
8. Similarly, for voyages connecting the Baltic Sea and the North Sea where no areas exist that meet the Ballast Water Exchange criteria according to the BWM Convention, to consider jointly with OSPAR adequate management measures, including possibilities for ballast water exchange. Ballast water exchange areas, if designated, should only be

in use until the D-2 Performance Standard of the BWM Convention becomes obligatory and for vessels/voyages posing an unacceptable high risk.

9. To join the OSPAR initiative to request vessels transiting the Atlantic or entering the North-East Atlantic from routes passing the West African Coast to conduct on a voluntary basis ballast water exchange before arriving at the OSPAR area or passing through the OSPAR area and heading to the Baltic Sea and to notify jointly with OSPAR the IMO of this action.

10. To undertake a similar initiative for vessels leaving the Baltic and transiting through the OSPAR region to other destinations so the ballast water would not be exchanged until the vessel was 200 nm off the coast of North West Europe in waters greater than 200 m deep.

11. To cooperate with OSPAR on any other relevant topics for the benefit of both regions and as necessary for harmonised implementation of the BWM Convention.

12. To cooperate for the development and exchange of experience concerning Ballast Water Treatment Technology.

13. To adjust/extend by **2010** the HELCOM monitoring programmes to obtain reliable data on non-indigenous species in the Baltic Sea, including port areas, in order to gather the necessary data to conduct and/or evaluate and consult risk assessments according to the relevant IMO Guidelines. As a first step, species that pose the major ecological harm and those that can be easily identified and monitored should be covered. The evaluation of any adverse ecological impacts caused by non-indigenous species should form an inherent and mandatory part of the HELCOM monitoring system.

14. To link by **2010** the port surveys and monitoring to Navigation Telex System (NAVTEX) or the equivalent, whereby ships can be alerted not to take up ballast water during outbreaks of harmful species and other high risk conditions.

15. To cooperate in order to establish by **2010, but in all cases not later than 2013** the regional information system for the relevant data obtained during port surveys, monitoring (including early warning system) and risk assessments to facilitate the implementation of the BWM Convention.

16. To provide by **2010, but in all cases before the latest target ratification date which is 2013** adequate reception facilities for sediments in ports and terminals where cleaning and repair of ballast tanks occurs based on IMO Guidelines G1.

17. To establish a correspondence group that regularly updates the current status in implementing the road map and that offers a forum to discuss relevant developments.

Input paper by the Baltic Sea States to IMO on a need to further address SOx emissions from shipping

With this document the Coastal States of the Baltic Sea want to provide relevant information concerning implementation of the requirements of Regulations 14(4) of Annex VI to MARPOL 73/78 in the Baltic Sea SOx Emission Control Area as an input to the current discussion on further reduction of SOx emissions from ships.

The Baltic Sea riparian countries discussed under the umbrella of the Baltic Marine Environment Protection Commission, also known as HELCOM, possible actions with regard to further reduction of the sulphur content limit of fuel oil used by ships in the Baltic Sea as well as globally.

MARPOL Annex VI entered into force on 19 May 2005 with the Baltic Sea area as an SOx Emission Control Area (SECA). Regulation 14(4) concerning the limit of sulphur content of fuel oil used on board ships in the Baltic Sea entered into force on 19 May 2006.

Before the regulation came into force there were several concerns regarding availability of low sulphur fuel oil and possible consequences for the enforcement of the regulations and economic impacts.

However, the experiences gained with the implementation and enforcement of relevant regulations in the HELCOM area were mostly positive. The information gathered to assess the enforcement of the regulation shows that the countries did not face any major difficulties in implementing Annex VI to MARPOL 73/78 as far as fuel oil quality was concerned.

Fuel oil with a maximum content of sulphur of 1.5% was available in the Baltic Sea ports as well as in European ports outside the Baltic. The availability of the fuel seemed to diminish with the distance from the Baltic Sea SECA where the requirements were less stringent on fuel oil quality. However, the Baltic Sea countries expect this to change with the North Sea becoming an SOx Emission Control Area and the entry into force of the relevant EU regulations.

From 17 May 2006 until 31 December 2006 as many as 1,879 ships were inspected in the Baltic Sea ports to control compliance with fuel oil requirements of Annex VI. The percentage of ships controlled out of the total number of ships calling into the Baltic Coastal State ports during the reported period ranged from 33% to less than 2%.

Only in 28 cases was non-compliance with the requirements of Regulation 18 “Fuel oil quality” of Annex VI detected, which is 1.5% of the all ships inspected. This indicates successful implementation of the relevant requirements in the Baltic Sea SECA.

The collection of information regarding implementation of MARPOL Annex VI in the Baltic Sea area will be continued to give more detailed information. No data are yet available for evaluation of the impact of implementation of Baltic SECA on air quality.

From the encouraging experience gained so far it can be concluded that even more ambitious aims concerning fuel oil quality are achievable globally as well as regionally within the next years.

The Committee is invited to take note of the information provided and to take action as deemed appropriate.

Action Plan for the protection of the environment from offshore platforms

The objective of this Action Plan is to ensure that environmental impacts from production and the preceding exploration for oil and natural gas remain within the limits set out in international and national regulations and correspond to principles of Best Available Technique (BAT) and Best Environmental Practice (BEP). Taking into account that most parts of the Baltic Sea Area have been declared by IMO as a Particularly Sensitive Sea Area and based upon BAT and BEP the "zero-discharge" principle* has already been implemented at a Russian offshore platform in the Baltic Sea, these principles shall be applied within forthcoming years to all existing, planned and under-construction offshore platforms (drilling rigs and production platforms) in the Baltic Sea Area.

The Action Plan covers the following elements and requirements:

Chemicals

All operators shall apply "zero-discharge" principle not later than 1 January 2010:

- by 23 April 2008 all operators must have ceased discharges of all "black" chemicals**;
- operators must continue the process of substituting chemicals so that discharges of "red" chemicals cease no later than 1 January 2010.

Discharges of oil

All operators shall apply the "zero-discharge" principle for polluted substances and materials not later than 1 January 2010, which means that:

- from 1 January 2008 operators must comply with a limit value for dispersed oil of 15 mg/l, in production water discharged into the sea, measured as volume-weighted monthly average;
- from 1 January 2010 any discharge of oil-containing water shall be prohibited.

Air emissions

All operators shall apply "zero-discharge" principle as soon as possible, which means that:

- emissions of NO_x and SO_x to air shall comply with requirements of Annex VI to MARPOL 73/78 from 1 January 2008;
- emissions of VOCs, CO_2 and other greenhouse gases should correspond to BAT (e.g. elimination of flaring, use of low sulphur fuel, introduction of NO_x-abatement techniques for combustion exhausts, introduction of CO_2 emission reduction methods and techniques).

Solid wastes

All operators shall apply "zero-discharge" principle not later than by 1 January 2008, which means that all solid wastes shall be disposed on land and treated in an environmentally good manner.

Decommissioning

All operators shall apply "zero-discharge" principle while decommissioning offshore installations at the end of their exploitation. The installations shall be removed, dismantled and subsequently treated in an environmentally friendly manner.

Environmental impact assessment, management, monitoring and reporting

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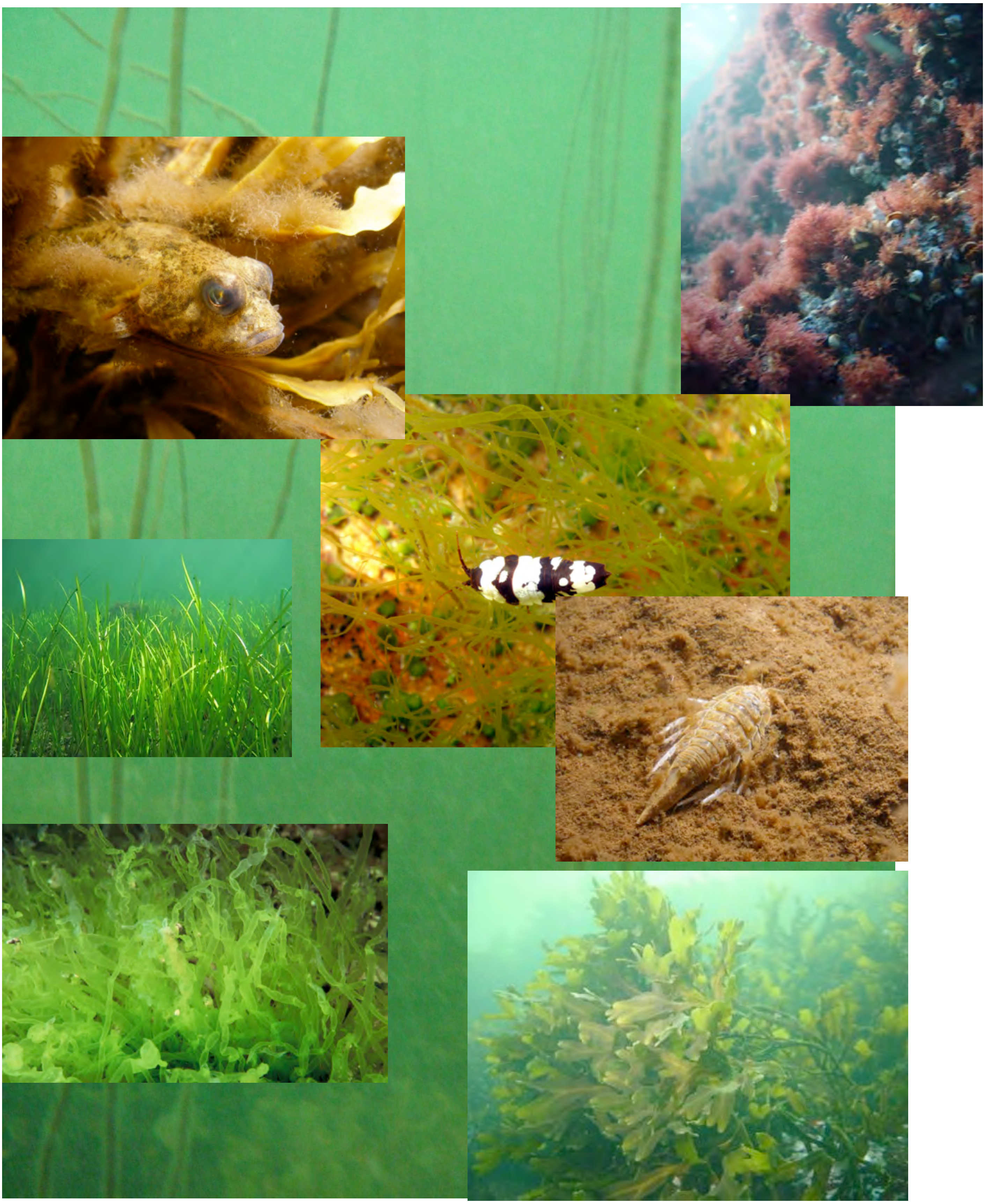
* *The "zero-discharge" principle means a general approach to ensure the proper treatment of all kinds of offshore platform-generated wastes, including processing and consumption wastes, on land or on the offshore platforms according to Best Available Techniques and Best Environmental Practices and MARPOL 73/78, with the aim of avoiding discharges to the marine environment.*

** *The lists of "black" and "red" chemicals are to be adopted at the HELCOM 29/2008 meeting, taking into account the OSPAR Recommendation 2000/4.*

- Any new plan for offshore activities shall undergo a thorough Environmental Impact Assessment (EIA) procedure, including, if needed, assessment in a transboundary context under the 1991 Convention on Environmental Impact Assessment in a Transboundary Context (in case of potential adverse impacts on neighbouring states). Upon launching of a new installation, respective post-project analysis of its environmental performance against provisions of the initial EIA shall be undertaken in accordance with the afore-mentioned Convention.
- By no later than 2008, operators must introduce environmental management under a system ready for certification or other similar scheme. If another scheme is chosen, an independent third party must verify compliance with the legislative requirements on environmental reporting and measurement methods.
- All existing facilities shall undergo a regular survey (monitoring) of their actual pollution load and impacts. Guidelines shall be adopted on the matter.
- The environmental performance of offshore activities shall be handled in accordance with HELCOM Guidelines (HELCOM Recommendation 18/2).
- For 2008 and thereafter, each operator must prepare an annual environmental report and make it available to the public. The report must describe the environmental impacts of the oil and gas production, including emissions and discharges of substances to the atmosphere and the sea.

Biodiversity in the Baltic Sea

An Integrated Thematic Assessment on biodiversity and nature conservation in the Baltic Sea



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PREFACE

Sixty different benthic landscapes, 150 biotopes, and a species richness of some 100 fishes, 400 plants, 500 benthic species, 3 000 planktonic organisms, and many thousands of unknown bacteria and viruses - that is a rough estimate of the biodiversity hidden under the Baltic Sea surface. These organisms and their ambient environment form the building blocks of the ecosystem and the interactions between all elements determine the characteristic features of the Baltic Sea.

During the last few centuries, human activities have gradually changed the Baltic Sea environment in many ways; loads of nutrients and hazardous substances have increased, resource extraction has intensified, and the physical environment has been modified by construction and dredging activities. After the Second World War the pressures have increased. The more we learn about the effects of these activities, the clearer it becomes that they have a profound and even irrevocable effect on the diversity of life in the sea. Today, changes to the Baltic ecosystem, such as reduced water transparency and shift in coastal bottom vegetation, are obvious also to laymen. The increased human pressure on the Baltic Sea has changed the ecosystem and thus undermined its structure and functions. This affects not only the characteristic appearance of the Sea but also the supply of goods and services that are recognized as valuable to society, such as revenues from fisheries and bathing waters free from algal blooms.

In order to improve the condition of the Baltic Sea, the Contracting Parties of HELCOM adopted in 2007 a plan to restore the good ecological status of the Baltic Sea, the Baltic Sea Action Plan (BSAP). One of the four main goals of the Action Plan is to achieve a favourable conservation status of Baltic Sea biodiversity. This biodiversity segment of the Action Plan can also be seen as a contribution to the wider goal of protecting biodiversity at a global level. Members of the European Union (EU) as well as the United Nations (UN) have agreed to halt the loss of biodiversity by 2010, including that of the marine environment.

With the BSAP the HELCOM Contracting parties also agreed to develop a common approach and tools for assessing the conservation status of Baltic Sea biodiversity. The current thematic assessment report can be seen as a contribution to fulfilling the task. The report is also the second thematic assessment report to be published following the HELCOM Monitoring and Assessment Strategy adopted in 2005.

The HELCOM Integrated Thematic Assessment of Biodiversity and Nature Conservation is the first comprehensive report of biodiversity and nature conservation in the Baltic Sea. The report provides a baseline for monitoring progress towards the goals and targets of the Baltic Sea Action Plan that relate to biodiversity. The ambition is to provide an overview of the state of Baltic biodiversity and nature protection in the beginning of the 21st century, to illustrate the links between the different pressures and activities in the Baltic area and the resulting environmental state, and to suggest steadfast recommendations to safeguard Baltic biodiversity. The report also introduces a new tool for assessing the status in relation to set targets concerning biodiversity and nature conservation of the Baltic Sea allowing a preliminary classification of conservation status.

CHAPTER 1. INTRODUCTION

1.1 An integrated thematic assessment of biodiversity and nature conservation in the Baltic Sea

The HELCOM Baltic Sea Action Plan as a background

The HELCOM Baltic Sea Action Plan (BSAP) was adopted in late 2007 by the environment ministers and high level representatives of the Baltic Sea coastal countries and the European Community (HELCOM 2007). By implementing the Action Plan, the HELCOM contracting parties are applying the ecosystem approach to management of human activities in the Baltic Sea region. Achievement of a Baltic Sea in good environmental status by 2021 is the ultimate goal of the BSAP.

The Action Plan attributes a specific chapter for nature conservation and biodiversity. The strategic goal for biodiversity is “Favourable conservation status of Baltic Sea biodiversity”. In addition, ecological objectives further define the status which HELCOM parties want to achieve:

- Natural marine and coastal landscapes,
- Thriving and balanced communities or plants and animals, as well as
- Viable populations of species.

For each of the ecological objectives, the Action Plan contains a number of more specific targets to be employed for monitoring the progress towards the strategic goal and ecological objectives.

A set of measures addressing biodiversity were adopted in the Action Plan, inter alia those concerning development of a marine spatial planning approach, finalisation of the coherent network of well-managed Baltic Sea protected areas, elaboration of habitat classification and updated Red lists of threatened and declining species and habitats, species protection, including a large number of fisheries related measures.

Biodiversity and nature conservation was included as a separate article into the revised Helsinki convention of 1992. Since then a number of HELCOM Recommendations in the field of protection of biodiversity and conservation of nature have been adopted. Those include recommendations on HELCOM Baltic Sea Protected Areas (Recommendation 15/5) and recommendations on protection of species, such as protection of seals in the Baltic Sea (Recommendation 27-28/2).

The purpose of this integrated thematic assessment of biodiversity is to provide a baseline for measuring progress towards the goals, objectives and targets identified in the Action Plan. This assessment will provide information on the status and pressures of biodiversity and nature conservation that prevailed before the implementation of the Action Plan. The changes in the status of the environment made as a result of implementing the management action of the Action Plan will be evaluated by a HELCOM ministerial meeting in 2013.

This biodiversity assessment will contribute to the development of harmonised assessment methods and tools. Particularly, the pilot application of the indicator based assessment tool BEAT contributes to development of quantitative assessment methodologies.

Topics of the biodiversity assessment

In accordance with the hierarchy of the biodiversity related ecological objectives of the BSAP, the assessment has been carried out at the levels of landscapes, communities and species (chapter 2, 3, 4 and 5)(Box 1.1).

Human pressures and activities have been assessed in terms of their sources, magnitude and their impact on Baltic biodiversity. The pressures include, similarly to what has been set out in the Marine Strategy Framework Directive (2008/56/EC), physical loss and damage, pollution and contamination by hazardous substances, nutrient enrichment and biological disturbance (chapter 6).

The report also includes a special assessment of the network of Baltic Sea Protected Areas (BSPAs) (chapter 7). The BSPA network is a central tool for protecting Baltic Sea biodiversity and it is essential from the point of view of nature conservation. In addition, one of the targets of the BSAP is to have, by 2010, an ecologically coherent and well-managed network of BSPAs.

Process of producing the assessment

This assessment is based on two pillars; an assessment based on time-series analyses conducted by experts on different aspect of Baltic biodiversity, and the development and pilot application of an indicator based assessment tool, the HELCOM Biodiversity Assessment Tool (BEAT).

The time-series analyses are based on data submitted by the national contact points of the project as well as directly by associated experts. The BEAT case studies, presented in chapter 5, are based on an assembly of records gathered through the HELCOM BIO project and the HELCOM project on the elaboration of an integrated thematic assessment of eutrophication in the Baltic Sea (HELCOM EUTRO-PRO). Together, the time-series and the BEAT analyses are used to evaluate the overall status of biodiversity and nature conservation in the Baltic Sea (chapter 8). The synthesis also discusses opportunities on how to improve biodiversity protection in the future.

1.2 A brief look at the past of the Baltic Sea and its biodiversity

The Baltic Sea has a long history of changing salinity conditions with marine and freshwater phases. This is clearly visible in fossil records where an alternating dominance by typical freshwater and marine species since the last glaciation period are observed (Berglund et al. 2005). The Baltic Sea with salinity levels and climate conditions close to the current ones has existed for about 3 000 years. In terms of ecological history this is a short period and the Baltic Sea still offers ecological niches available for immigration (Bonsdorff 2006).

The Baltic Sea is still a highly dynamic system. During the last one hundred years the system has undergone decadal variations in salinity, oxygen and temperature (Winsor et al. 2001). Changes in the abundance and distribution of pelagic and littoral species and communities in the central and northern parts of the Baltic Sea have been linked to these climate driven variations in hydrography (Alheit et al. 2005).

In the last decades, the increased anthropogenic pressures on the Baltic Sea marine environment have, as will be seen throughout this report, contributed to considerable changes in biodiversity. There are also a few cases of extinction of species that have been established in the Baltic Sea in recent history. The most well-known example is that of Atlantic sturgeon (*Acipenser oxyrinchus*), that after over-exploitation by fisheries and obstruction of migratory pathways has only been recorded occasionally since the 1960s (Paaver 1999). Due to the open link to the North Sea there are also a number of marine species that have occasionally migrated into the Baltic Sea but that are absent or rarely observed at the present. The bluefin tuna (*Thunnus thynnus*), for example, was abundant and the subject of commercial fishing in the Kattegat and Sound in the beginning of the 1900s, but has disappeared from these areas in the 1960s (MacKenzie & Myers 2007). Currently there is a total of 59 species and 16 biotopes that are considered as threatened and potentially also declining in the Baltic Sea area (HELCOM 2007b) (Figure 1.1).

1.3 Current Baltic biogeography

The species diversity in the Baltic Sea is low compared to open oceans and most freshwater systems, primarily due to the brackish water that constitutes a stressful environment for many aquatic organisms.

The seabed of the Baltic Sea is shaped into sub-basins separated by shallows sills. Each basin is characterized by different depth, volume and water exchange, thus resulting in sub-basin-specific chemical and physical properties. In addition, the Baltic Sea has a highly varied coastline and seabed. Large archipelago areas add to this diversity. All these factors have a profound influence on the proliferation and distribution of species on a sub-regional as well as local scale.

Salinity sets boundaries for existence

Salinity in the Baltic Sea is primarily determined by freshwater inflow from rivers and the influx of saline water from the North Sea through the Danish Straits (Lass & Matthäus 2008). There is a pronounced salinity gradient from south to north: surface water salinity averages 20 psu in the southern Kattegat, 8 psu in the Baltic Proper and 5 psu in the Bothnian Sea. In the innermost parts of the Gulfs of Bothnia and Finland the water is practically limnic with a salinity <1 psu.

The number of species also decreases dramatically along the south-to-north gradient. A particularly steep decrease takes place across the Danish straits. In the open Skagerrak there occur about 1 600 benthic species, decreasing to 500 in the southwestern Baltic Sea, while less than 20 inhabit the bottoms of the Bothnian Sea (Bonsdorff 2006). The total number of macroalgal species drops from about 250 in the Öresund area to about 40 in the Bothnian Bay (Nielsen et al. 1995).

The primary reason for the low diversity is that very few species are endemic to brackish conditions in general or to the Baltic Sea in particular. Instead, both marine and limnic species meet their physiological limits in the Baltic. The eelgrass *Zostera marina* has its geographic distribution limit at about 5 psu coinciding with areas in the southern Bothnian Sea. Vendace (*Coregonus albula*) on the other hand is an example of a freshwater fish that tolerates brackish waters and is found in coastal waters of the Bothnian Bay and the northernmost Bothnian Sea. Distribution of cod (*Gadus morhua*) is also limited by salinity. Successful spawning of cod requires a relatively high salinity (> 11 psu) that primarily exists in the deep basins of the Baltic Proper. Adult cod however migrate to all basins except the Bothnian Bay (Figure 1.2).

Physiological stress is manifested in the limited body size and slower growth rate of some marine species that inhabit the Baltic Sea. Individuals of blue mussels (*Mytilus edulis*) present on hard bottoms in the northern Baltic Sea are much smaller and have a slower growth rate than those in the Kattegat (Kautsky et al. 1990). Bladderwrack (*Fucus vesiculosus*) is found down to a salinity of 4 psu. The Baltic bladderwrack is however smaller and displays a lower photosynthetic production potential than bladderwrack in the Atlantic (Nygård & Ekelund 2006).

Oxygen conditions determine life in the deep

Vertical stratification of the water column is a predominant feature in all Baltic basins (e.g. Lass & Matthäus 2008). Stratification is caused either by a seasonal temperature gradient or by a more permanent halocline. Salinity stratification is due to mixing and layering of the high salinity waters of marine origin with the fresh waters originating from run off, and it is particularly pronounced in the open Baltic Proper and the western Gulf of Finland.

The halocline prevents vertical mixing of the water column and consequent ventilation of the deeper layer. Oxygen in the deeper layers is consumed by microbial degradation processes. With the prevention of ventilation by vertical mixing this results in pronounced periods of oxygen deficiency or complete anoxia and occurrence of hydrogen sulphide. Long term anoxia, also called stagnation, is prevalent especially in the deeper layers of the Baltic Proper. In shallower basins such as the Bothnian Bay and Bothnian Sea the vertical salinity and temperature differences are much less pronounced and the water column generally mixes every year resulting in good oxygen conditions in the bottoms of both basins. Oxygen deficiency can also be seasonal, often taking place in the autumn in coastal waters.

The stagnation periods are directly related to major inflows of saline water to the Baltic Sea which largely depend on climatic factors, especially travelling depressions that result in sea level differences between the Kattegat and Arkona Sea (Lass & Matthäus 2008). These inflows are in principle the only source of oxygenated water to the deepest parts of the Baltic Proper. For the benthic fauna that depend on oxygenated conditions, these inflows determine the very conditions for existence. When the oxygen concentration drops below 2 ml per liter (hypoxia) during extended periods, higher life-forms are obliterated and the bentho-pelagic processes become dominated by anaerobic bacteria.

Since the mid 1970s major inflows of saline water became rare with no intrusions taking place at all between 1983 and 1993 (Lass & Matthäus 2008). The latest major inflows of saltwater to the Baltic Sea occurred in 1993-1994 and 2002-2003. Since then hypoxic and anoxic areas have increased in the Baltic Proper and Gulf of Finland and in autumn 2006 and spring 2007 they corresponded to half of the surface area of the basins (Axe 2007, SEPA 2007). Anoxia drives liberation of nutrients, phosphorus in particular, from the sediments, and thereby exacerbates eutrophication.

Coastline, substrate and light penetration shape sub-regional and local diversity

The coastline of the Baltic Sea is highly varied with exposed bedrock and extensive rocky archipelagos in the central and northern Baltic, sandy beaches and eroding cliffs along the shores of the southern Baltic Proper, shallow lagoons along the German and Polish coasts, and fjords in the Belt Sea and Kattegat (HELCOM 1998). Shape and exposure of the coastline affects the substrate of the seafloor and the rate of water exchange in the coastal zone. The latter in turn influences the salinity and nutrients levels in the costal area. Open and exposed areas of the Baltic Sea therefore harbour different communities than enclosed and sheltered coastal areas (Olenin & Daunys 2004).

For animals and plants associated with the bottom, the substrate is an important selective factor within the salinity regimes of the different Baltic sub-regions. For aquatic vegetation, light penetration, wave exposure, and also ice conditions are factors that further structure the distribution of species in the coastal zone. When the ice brakes up in spring, shallow bottoms in exposed areas can be scoured down to 1-2 metres resulting in dominance of annual species. The Bothnian Bay, Bothnian Sea, Gulf of Finland and Gulf of Riga are covered by ice during an average winter, with decreasing length of the ice season towards the south. In the coastal zone ice is common all along the coasts of the Baltic Proper. There is however a general tendency towards a shortened ice season and decreasing annual extent of sea ice in the Baltic Sea (HELCOM 2007a).

Within each sub-basin, salinity, nutrients and temperature are important factors affecting the temporal variation in diversity, particularly in the littoral and pelagic communities that undergo a pronounced seasonal succession. The difference in seawater temperature between the northern and southern parts of the Baltic Sea is not pronounced enough to act as a driving force of species selection between the sub-basins. However, seasonal succession is affected by temperature resulting in for example earlier phytoplankton spring blooms in the southern Baltic than in the north.

1.4 Why does Baltic biodiversity need protection?

The biodiversity of the Baltic Sea provides a variety of goods and ecosystem services. Nutrient recycling, water and climate regulation, production of fish and other food items and recreational opportunities are among the ecosystem services provided by the Baltic Sea (Rönnbäck et al. 2007). The most obvious goods are fish which also have a market value. The annual value of fish catch in the western Baltic Sea (Denmark, Germany, Finland and Sweden) was estimated at 1 520 million euros in 2001 (COWI 2007).

On a global scale, marine ecosystems have been estimated to produce 63% of all world's ecosystem services with the total annual value of 33 trillion (10^{12}) US dollars (Constanza et al. 1997). The Baltic Sea is among the most productive ecosystems with much of the area providing services with an annual worth in the range of 2000 to 3 000 US dollars per hectare (Constanza et al. 1997).

Ecosystem goods and services also include a number of invisible benefits that are not directly valuable to humans. These include the features and processes which are important for the maintenance of the ecosystem, such as resilience and provision of habitats (Beaumont et al. 2007). The significance of "diversity" is highlighted by its role in supporting the capacity of the ecosystem to adapt to changing conditions. In this respect there are several features that make the Baltic Sea ecosystem particularly vulnerable to changes in biodiversity and these particular attributes have to be considered in the management of the Baltic Sea.

Landscape diversity provides the basis for habitat diversity

Maintenance and protection of species diversity is inextricably linked to preservation of the environment that serves as a habitat for the species and populations in question. Seagrass (*Zostera marina*), bladderwrack (*Fucus vesiculosus*), and blue mussels (*Mytilus edulis*), for example, are considered among the key species in the Baltic Sea since they form a structure that is the habitat for many other species during parts or the entire span of their life. The presence of these communities is in turn dependent on seabed features such as bottom substrate i.e. their potential distribution is determined by the marine landscape.

When key species have a large influence on the structure of the ecosystem, such as in the Baltic Sea, the systems are often characterized by low resilience. When designating protected areas it is thus very important to include landscape features that are known to support these key species.

Functional diversity is an insurance against species loss

Functional groups refer to organisms that can be characterized by common traits or roles in the ecosystem such as feeding behaviour, capacity to conduct certain biogeochemical processes, or the occupation of a specific niche. For the ecosystem to uphold a certain function, for example productivity, the number of functional groups as well as the diversity within a functional group are key properties (Walker 1995, Nyström 2006). If diversity within a functional group is high a species can even be lost, in the short-term, without affecting the ecosystem function.

In the Baltic Sea, functional diversity is well documented for invertebrate bottom dwelling animals. Due to the pronounced salinity gradient in the Baltic Sea the number of functional groups drops from the south to north direction; from 20 in the Kattegat-Skagerrak transition area, to 8-10 in the southern Baltic Proper and down to 1-2 in the Bothnian Bay (Bonsdorff & Pearson 1999). In addition, the number of species within the functional groups drops from 4-5 in Kattegat-Skagerrak to 1-2 in the Baltic Sea (Bonsdorff & Pearson 1999). Thus, the Baltic Sea is characterised by a low number of functional groups as well as a low diversity within the functional groups. The low diversity accentuates the unique role of each Baltic species not only within the functional groups but also in the ecosystem at large.

Trophic diversity safeguards the structure of the ecosystem

Large predators have an important structuring role in the ecosystem and the trophic levels can be considered as a vertical diversity of the food web. Reduction of top-predators through fishing or hunting has been shown to cause trophic cascades, in many aquatic environments, i.e. by affecting the abundance of organisms in several steps of the food chain (Estes et al. 1998, Pace et al. 1999, Reid et al. 2000, Frank et al. 2005).

Evidence of change in the trophic structure can also be found in the Baltic Sea where the fish community shifted from cod dominated to sprat dominated in the late 1980s (Österblom et al. 2007). This has been attributed to a combined effect of high fishing pressure on cod and climatic forcing which has given the sprat stock a competitive advantage (Köster et al. 2005). It has been proposed that sprat and herring stabilize the new regime by feeding on cod eggs and larvae.

Genetic diversity increases the ability to recover

Genetic variation within a species has great importance for the individual species' capacity to establish, recover and adapt to new conditions. The Baltic Sea has two features that make protection of the genetic diversity especially important; the genetic diversity is low from the onset and many genetic traits are unique.

Comparison between species from the Baltic Sea and the Skagerrak-Kattegat area has shown that cod and eelgrass of the Baltic Sea have a lower genetic diversity than their counterparts in the more saline environment (Johannesson & André 2006). The same pattern is true for macroalgae. The low genetic diversity indicates that the species of the Baltic Sea may be particularly sensitive to disturbances.

Species from the Baltic Sea also display distinct genetic traits, indicating that they have adapted to the specific conditions of this sea area. The cod eggs of the eastern Baltic Sea stock are for instance larger and have a lower density than the North Sea cod eggs. This makes them "float" better at a lesser depth which is also more often well oxygenated (Vallin & Nissling 2000). With little redundancy in genetic variation possibilities for replacement by other variants are more limited in case of loss. Moreover, if genetic variants are lost there is no depository from which they can be collected and reintroduced.

Diverse systems are more resilient

As an ecological concept, resilience describes the capacity of an ecosystem to absorb disturbances while maintaining structure and function (Holling 1973, Walker et al. 2004). In this sense, a "resilient" ecosystem can appear virtually unaffected while exposed to considerable stress. The apparent lack of response can be explained by natural feed-back mechanisms such as biogeochemical compensation, regulation through trophic and competitive interactions within the system, and to a certain degree also by the functional redundancy among species. However, at a certain point even a small increment in external pressure can cause a dramatic shift – a so called regime shift – that result in the collapse of populations or other characteristics of the ecosystem (Scheffer et al. 2001). An idiom that reflects this type of event is "the straw that broke the camel's back".

In the Baltic Sea, several regime shifts driven by variability in climate, eutrophication, as well as seal hunting and fishing pressure have already occurred during the last 80 years (ICES 2007 and 2008, Österblom et al. 2007) (Box 1.2). Once anthropogenic pressures have caused regime shifts, extensive and costly management actions are generally needed to revert the situation since new feed-back systems come into play that contribute to stabilizing the new regimes (Troell et al. 2005). From management's point of view it is therefore essential to avoid reaching the break point where regime shifts occur.

There is ample evidence for a positive relationship between the number of species and ecosystem productivity and stability over time as well as for the capacity of an ecosystem to recover after disturbances (Naeem & Li 1997, Worm et al. 2006). Changes in the environment that result in decreased biodiversity are therefore considered as making systems less resilient and more prone to undergo regime shifts (Folke et al. 2004). In an ecosystem such as the Baltic Sea that has low species, genetic, and functional diversity from the onset, protection of biodiversity is thus a key factor for ensuring ecosystem resilience.

1.5 Protection of biodiversity – Global and European targets

Protection of biodiversity is an integral part of the ecosystem approach to management of human activities. The United Nations Convention on Biodiversity from 1992 has laid the basis and concepts for much of the work on biodiversity protection. At the UN World Summit on Sustainable Development, in 2002, the governments committed themselves to significantly reducing the rate of biodiversity loss by 2010. Halting the loss of biodiversity by 2010 is also a target for EU member states. This assessment will contribute to monitoring the progress towards the targets and to promoting measures enabling achievement of the biodiversity targets for 2010.

HELCOM's work on protecting biodiversity and conserving nature has a strong region-specific focus and it contributes to activities taking place under the Bern Convention on the Conservation of European Wildlife and Natural Habitats and the Bonn Convention on the conservation of migratory species of wild animals. EU has adopted two important pieces of legislation which have provided the basis for implementing the above conventions. These are the Bird Directive (79/409/EEC) and the Habitats Directive (92/42/EEC). These directives also lay out the requirements for the development of the European network of protected areas, the Natura 2000 network, and they include important provisions on the protection of species and habitats in the EU member states.

EU Water framework Directive (WFD) focuses on the internal, transitional and coastal waters and includes the objective of achieving good ecological status by 2015 in the waters of the EU member states.

To protect the marine environments in Europe, the EU institutions adopted in 2008 a framework directive, the Marine Strategy Framework Directive (2008/56/EC). The Directive aims to achievement of good environmental status of the European marine environments by 2020. The marine strategies to be elaborated by EU member states will include preparation of initial assessments of the status of the marine environment, as well as of the predominant pressures impacting the environment by 2012. This report makes an important marine region level contribution to elaboration of such assessments. The directive includes spatial protection measures as a part of programmes of measures to be elaborated and operationalized. This report will provide an overview of the extent to which coherent and representative networks of marine protected areas had been established in the Baltic Sea area by 2008.

1. FIGURES

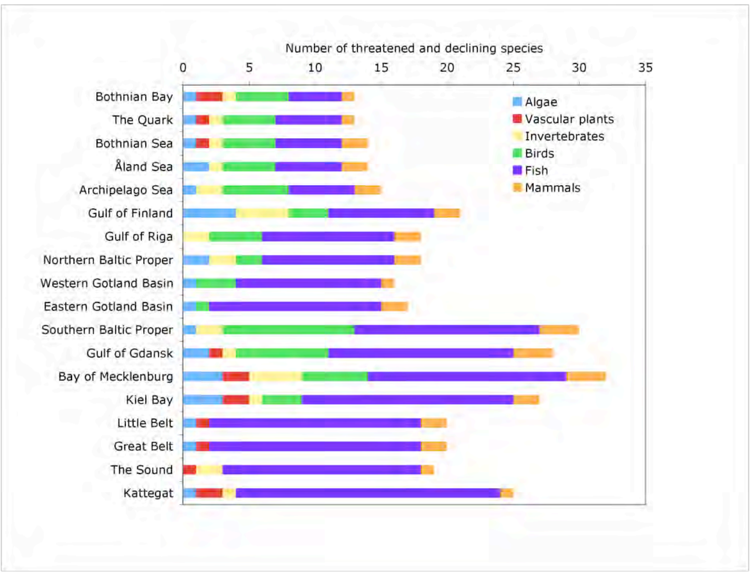


Figure 1.1. Number of threatened and declining species in the Baltic Sea. HELCOM 2007b.

Figure 1.2. Production in progress: Map with distribution limits of Baltic Sea species.

1. BOXES

Box 1.1. Biodiversity

The term biodiversity is simply a short version for the two words "biological diversity", coined by Edward O. Wilson in the 1980s. The concept embraces not only the variety of living organisms but also the genetic diversity within a species, as well as the diversity of habitats and landscapes. The formal definition given by the Convention on Biological Diversity is that "Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

It should be noted that the term biodiversity can be used in widely different contexts and with different meanings. In a management context, like in this report, the abstract term "biodiversity" only serve a useful purpose if it can be concretized in the form of e.g. specific species or indicators that reflect the "health" of the ecosystem, rather than the absolute diversity. In this context the link between state of the indicator and human pressures should also be established in order to enable remedying actions.

Box 1.2. Regime shifts in the Baltic Sea – as detected by an Integrated Ecosystem Assessment

The ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB) has conducted Integrated Ecosystem Assessments (IEA) in a number of offshore and one coastal sub-region of the Baltic Sea (see table). IEAs are multivariate analyses of time series of the physical, chemical and biological environment as well as socio-economic factors. The analyses were targeted to assess the impact of climate, fisheries and eutrophication on the different sub-regions.

All seven investigated sub-regions displayed pronounced structural changes, i.e. regime shifts, in the last two to three decades. The major period of reorganisation in the Baltic sub-regions was at the end of the 1980s. The Sound, Central Baltic Sea, Gulf of Riga, Gulf of Finland and Bothnian Bay also underwent structural change during the mid 1990s, probably related to the major inflow in 1993.

For the Central Baltic Sea, two relatively stable periods were detected in 1974-1987 and 1994-2006. The first period was characterized by comparatively high cod and herring spawner biomass and recruitment, and high abundances of the copepod *Pseudocalanus acuspes*, whereas in the later period the system was sprat-dominated with high abundances of *Acartia* spp. and *Temora longicornis*. Between the two shifts, there was a transition period of highly variable climatic and hydrographic conditions and no major inflow events, resulting in low salinity and high temperature values.

The main drivers of the observed ecosystem changes vary between sub-regions, but they all include the increasing temperature and decreasing salinity influenced by large-scale atmospheric processes. In addition to temperature and salinity, fishing pressure was identified as an important driver for Central Baltic Sea and Bothnian Sea as well as nutrients for the highly eutrophicated Gulf of Finland.

System	Period covered	RS 1	RS 2	RS 3	RS 4
The Sound	1979-2005		1987/88	1995/96	
Central Baltic Sea	1974-2006		1987/88	1994/95	
Gulf of Riga	1974-2006		1988/89	1997/98	
Gulf of Finland	1979-2007		1988/89	1995/96	2002/03
Bothnian Sea	1979-2006	1982/83	1988/89		
Bothnian Bay	1979-2006		1987/88	1993/94	
Kvädöfjärden, Northern Baltic Proper	1971-2006	1976/77	1987/88		2004/05

CHAPTER 2: MARINE LANDSCAPES AND HABITATS

Habitats describe the abiotic characteristics of an environment and its associated biological assemblages at high level resolution. Marine landscapes provide a simple broad scale overview of the often complex interactions of the various oceanographic and physical factors constituting the marine environment. In general, areas with high landscape and habitat diversity can be expected to harbour a higher diversity of species. Coherent knowledge of the underwater landscapes and habitats is therefore crucial for informed nature conservation and the designation of marine protected areas.

This chapter presents the current development of marine landscape maps in the Baltic Sea and the conservation and threat status of Baltic habitats and biotopes."

2.1 Marine landscapes

The shores of the Baltic Sea reveal a highly diverse landscape scenery with coastal lagoons, shallow bays, extensive sandy beaches and many islands. Similarly, though hidden from sight beneath the surface exists an unique and largely undiscovered world of flooded canyons, deep sea mud basins as well as rippled sandy plains with isolated rocky patches raising from the surrounding seafloor – these are the marine landscapes of the Baltic Sea. The diversity of landscapes represents the range of living conditions available for the species and communities in the Baltic Sea. As such a coherent marine landscape map is a fundamental tool for managing the biodiversity in the Baltic Sea marine ecosystem.

One of the overarching ecological objectives of the Baltic Sea Action Plan is to achieve a good ecological status of *"Natural marine and coastal landscapes"*. A target of the BSAP is also to *"By 2021 ensure that "natural" and near-natural marine landscapes are adequately protected and the degraded areas will be restored"*. This target of course requires that the marine landscapes are identified, mapped, their biological and ecological relevance described, and that the overall map is quality assured. The next step will be to incorporate the use of the marine landscape map into maritime management through identification of indicators for ecosystem health and environmental thresholds e.g. which percentage of a marine landscape should be preserved from human pressure in order to maintain a healthy ecosystem. To reach this goal linkage to maritime spatial planning would be beneficiary.

2.1.1 Marine landscapes – the concept

The concept of marine landscapes as a simple, yet ecological meaningful way to describe the vast, and often unknown, expanses of the seafloor was originally presented for Canadian off shore waters. The aim was to inform marine nature conservation. The idea was to develop a tool, which could help environmental managers to enhance marine nature conservation schemes and, in general, inform marine spatial planning. The main criterion was that the marine landscape approach should be based on sound ecological principles and support an informed approach to management of marine areas (Roff & Taylor 2000). The derived marine landscapes should also be individually distinct and reflect broad-scale species assemblages. Marine landscapes are, in principle, especially valuable in areas for which little biological information is available, e.g. such as in most off shore areas.

By recognizing this, marine landscapes has since the turn of the century been tested in Europe by e.g. the Joint Nature Conservation Committee in the Irish Sea Pilot Project. An initiative, which later was expanded to include the entire UK territorial water in the UKSeaMap (Vincent et al. 2004, Connor et al. 2007). Likewise, the UK has through MESH (Mapping European Seabed Habitats) cooperated with France, Ireland, Holland and Belgium to improve the classification and mapping of seabed habitats for the NW European waters. These mapping initiatives reflect the increased demands for the development of tools supporting an ecosystem-based approach to management that has appeared on the European scene over the last two decades. Such demands are amongst others illustrated by the EU Habitats Directive, the EU Water Framework Directive, the EU Marine Strategy Framework Directive as well as the EU Maritime Policy initiative for developing "An European Atlas of the Seas". For the Baltic Sea Region the needs have been made even more concrete with adoption of the HELCOM Baltic Sea Action Plan in 2007.

Through the Baltic Sea Action Plan the countries surrounding the Baltic Sea has agreed upon a wide range of topics about securing the general protection of the Baltic Sea. This requires the development of coherent ecological relevant maps spanning the entire Baltic Sea Marine Region, such as marine landscapes.

The BSR INTERREG IIIB part-financed "BALANCE" project has provided a first step towards identifying and mapping the marine landscapes of the Baltic Sea. This development process has included facing i) the challenges related to data availability, ii) harmonisation, and iii) access that is part of the daily life in the multinational, multiple stakeholder environment of the Baltic Sea Region (Al-Hamdani & Reker eds. 2007).

2.1.2 Development of marine landscapes maps

In order to assess the conservation status a coherent broad-scale ecological habitat map spanning seamlessly across the HELCOM Region is needed. At the same time the map has to meet the statuary requirements stated by HELCOM and EU policy initiatives such as e.g. the Baltic Sea Action Plan and the EU Marine Strategy Framework Directive. The marine landscape maps provide such a tool.

The marine landscape maps for the Baltic Sea include three different classifications: i) the benthic marine landscapes, which describes the seabed in an ecological meaningful way, ii) the topographic features, which describes the seabed geomorphological complexity, and iii) the physiographic features, representing the shape of the coast. A biological validation has only been done for the benthic marine landscape map. Furthermore, it was not possible to identify ecological relevant criteria for delineating the topographic and physiographic features, and these are therefore not, at this point, suitable for broad-scale environmental assessments.

Methodology

When developing the Baltic marine landscape maps, the primary environmental parameters were chosen among those listed in Annex III of the EU Marine Strategy Framework Directive. These were sediment, available light and salinity at the sea floor (Figure 2.1.1a-c).

The composition of the sediment is a major determinant for the distribution of benthic species and detailed, high-resolution sediment composition maps are essential for marine landscape and marine habitat mapping efforts. The sediment map presented here was collated by harmonising data from 19 different geological classifications systems written in 9 different languages. The sediment was split into 5 categories ranging from bedrock to mud each with different ecological relevance.

From an ecological point of view available light at the seabed is one of the primary physical parameters influencing and structuring the biological communities in the marine environment as it is the driving force behind the primary production. Available light was included as it distinguishes between the photic zone where the primary production occurs and the non-photic zone.

Salinity was split into 6 categories reflecting species distribution boundaries or ecological requirements throughout the Baltic Sea. Unfortunately, no coherent data for benthic species covering the entire Baltic Sea Region that can link species distribution and salinity is available. Focus was therefore on known requirements of certain key species e.g. at what salinity does Bladder wrack *Fucus vesiculosus* become the dominating submerged brown algae. Table 2.1.1 summarises the reasoning between specific categories.

Other environmental parameters were considered, but these were either more relevant for detailed habitat mapping purposes e.g. wave exposure, not relevant for the entire region e.g. ice cover, not significantly influencing the species distribution in the Baltic Sea e.g. temperature or lastly, of only minor importance compared to other geographic areas, such as tidal currents. Lastly, the aim was to limit the number of marine landscapes to a manageable number (see Al-hamdani & Reker 2007 for details). Using this approach, 60 marine landscapes were identified in the Baltic Sea (Figure 2.1.1d, Box 2.1.2).

How far can we trust the maps?

An essential point for the durability of the benthic marine landscapes is that the maps actually do reflect broad-scale species assemblages in the Baltic Sea. If they do not do meet this criteria, they are of limited use for supporting a sustainable management of human activities in the marine environment. The benthic marine landscapes have been validated through, so far, two initiatives, which have shown that even closely, related landscapes represent significantly different biological communities. In the Kattegat 106 stations were selected for sampling of the benthic communities. The area covered three closely related “muddy” marine landscapes. A statistical analysis showed that there was a significant difference between the species assemblages present within the three marine landscapes surveyed (Al-hamdani & Reker 2007). If marine landscapes with another dominant sediment type, e.g. photic rock, were to be compared to these marine landscapes it is obvious to assume that the difference would be even more significant. However, a thorough validation and refinement process should be continued based on national monitoring data by those Contracting Parties who might wish to adopt this approach as an environmental characterisation of the Baltic Sea Marine Region sensu the EU Marine Strategy Framework Directive. Ideally, the marine landscape map should be supported by detailed habitat mapping applying the EU EUNIS classification system.

The top three levels of the EUNIS system, which describe the physical environment, are using a similar approach as the marine landscapes. To be able to map EUNIS habitats at level 4 and higher, coherent species information, including species lists and their abundances, are needed to develop a hierarchical classification of marine habitats. Marine landscapes are used to provide a coherent, coarse broad-scale ecological relevant map for marine areas. They are developed using the criteria defined by the Marine Strategy Framework Directive. However, physical environmental parameters structure the distribution and the biology of the species, which makes marine landscapes ecologically relevant.

In summary, it is possible to produce a broad-scale, ecological relevant map spanning an entire Marine Region consisting of multiple independent States e.g. the benthic marine landscapes of the Baltic Sea.

2.1.3 Application

The potential uses and applications of marine landscape maps are many. Most importantly, they can be used as a basic ecological information layer in a marine spatial planning process or for ecosystem-wide assessments. In the BSAP, the contracting parties have agreed to use broad-scale cross-sectoral maritime spatial planning as a tool to reduce the impact of human activities on the Baltic Sea. This could be concerning assessing the sum of environmental impact of human activities, help informing about the total resource available or by providing valuable information for strategic planning of large-scale infrastructures.

It is possible to develop an index of the relative seabed complexity based on the marine landscape map. Figure 2.1.2 illustrates how complex the seabed is within a 20 km x 20 km area based upon the number of marine landscapes present in that specific area. In the Baltic Sea some areas are very homogenous with only one marine landscape present within a 20 km grid whereas other places are more heterogeneous with up to 19 different marine landscapes are present. I should be noted that even if there is only one marine landscape present (dark green) it might be a different one present in the neighbouring grid and therefore the complexity map should always be used in close connection to the marine landscape map. The index can be applied to illustrate e.g. the potential “hotspots” with a high complexity or many landscapes present within a small area compared to areas with less complexity. Such information provides planners and environmental managers with a strategic tool to identify potential important areas or “hotspots” that might need special attention during the planning process. Hotspot areas include the Swedish west coast, the Danish Straits and the Sound at the entrance to the Baltic Sea, around the northern part of the island of Gotland and the Gulf of Finland.

Most importantly, the benthic marine landscape map provides a coherent ecological relevant map of the HELCOM Region. This map can, and has been used (Andersson & Liman 2007; Liman et al. 2008), to assess the coherence, adequacy and representativeness of the network of marine protected areas in the Baltic Sea Region through a systematic approach. As such the marine landscape map are an important tool for informed management of the marine environment. This is further discussed in chapter 7 of this report.

2.1.4 Conclusions

In conclusion, marine landscape maps covering entire ecoregions are potentially a strong tool providing a basis for a broad-scale spatial approach to the planning and management of the marine environment. The approach presented here is a fully applicable and usable ecologically relevant characterisation of the Baltic Sea. However, end users might find it necessary to continue the refinement and improvement of the maps. Such refinements are necessary in order to fully exploit the potential application of the maps and for linking them to the implementation of national legislation, EU Directives and other policy documents such as the Baltic Sea Action Plan and the EU Maritime Policy. The future success of producing marine landscape maps with a higher accuracy and precision depends on access and availability of existing data as well as a transnational and cross-sectoral approach spanning the Baltic Sea. As such, the work presented here and by the BALANCE project should be seen as a first step towards the broad-scale mapping of the marine landscapes in the Baltic Sea to be further developed by EU Member States for implementing EU maritime policy and legislation.

2.1.5 Recommendations

The following recommendations are in regard to improving overall map quality:

- A coherent data set of benthic fauna and flora should be collated using the same sampling methodology, not just the same guidelines, covering the entire HELCOM Region.
- The environmental parameters, e.g. the salinity categories, should be harmonised using a coherent data set of benthic species data spanning the HELCOM Region through a multivariate analysis.
- The benthic biological communities present within individual marine landscapes should be described in more detail.
- A throughout validation of the map should be done for each HELCOM subregion. A step-wise approach using national territories or HELCOM subregions could be considered.

The following recommendations are in regard to applying the marine landscape maps in maritime management:

- Thresholds should be established for individual landscapes such as how large a proportion of a marine landscape can be influenced by a single pressure e.g. oxygen depletion or a sum of pressures, without ruining the ecological services provided?
- Targets based upon the marine landscapes should be developed and tested at the regional scale. For example, is the area influenced by oxygen depletion getting smaller over a period of time?
- The marine landscape maps should be used in systematic regional assessments enabling an objective comparison and status evaluation between periodically assessments.
- The use of ecological relevant maps should be further developed for maritime spatial planning as a tool for securing a long-term sustainable development.
- Pelagic landscape maps should be developed following the same ecological relevant principles as for the benthic marine landscape maps.
- The continued development of the marine landscapes should be kept within an international context covering the entire HELCOM Region in order to enable the development of a coherent harmonised map. A one nation, one approach will not provide the tool needed.

2.1 TABLES

Table 2.1.1: Categories for sea bottom salinity and their justification based on expert judgment

Category	Salinity range	Justification
Oligohaline I	< 5psu	This picks up the biogeographic boundary in the Quarken area. This region has a higher content of fresh water species.
Oligohaline II	5 – 7.5psu	7.5psu equals roughly the area where *Fucus serratus* has its distributional boundary (Öland, SE) making *Fucus vesiculosus* the dominating sublittoral brown algae. This category also has the lowest number of species and is thus the most vulnerable part of the Baltic Sea.
Mesohaline I	7.5 – 11psu	11psu is the minimum requirement enabling cod (*Gadus morhua*) eggs to float. As cod is an important commercial species for the Baltic Sea Region this interval was chosen in order to increase applicability of the marine landscapes for environmental management. It also helps to separate offshore environment from coastal areas in large parts of the Baltic proper.
Mesohaline II	11 – 18psu	18psu is the minimum requirement (roughly) for sexual reproduction or limiting distribution of many marine macroalgae, e.g. *Laminaria digitata* and *Ascophyllum nodosum*, and of e.g. Echinoderms. Picks up the biogeographic boundary in the Sound. 18psu is also the boundary in the EU Water Framework Directive further increasing the applicability of the marine landscape maps.
Polyhaline	18 – 30psu	Most marine species are able to survive within this interval. It is also an interval defined by the EU Water Framework Directive.
Euhaline	> 30psu	Requirement of truly stenohaline species separating the marine parts of the Skagerrak and North Sea from the fresh water influenced water masses of the Kattegat and Baltic Sea region.

2.1 FIGURES

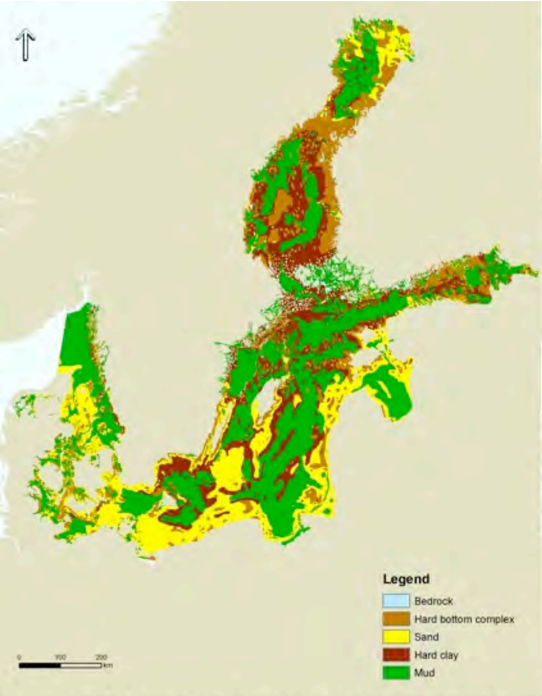


Figure 2.1.1a. Marine seabed sediment divided into 5 categories in the Kattegat and Baltic Sea compiled from sediment information from GEUS, GSF and SGU.

Figure 2.1.1b. Model results showing the distribution of where at least 1% available light touches the seabed (the photic zone) and non-photic zone. Data source: DHI and ICES.

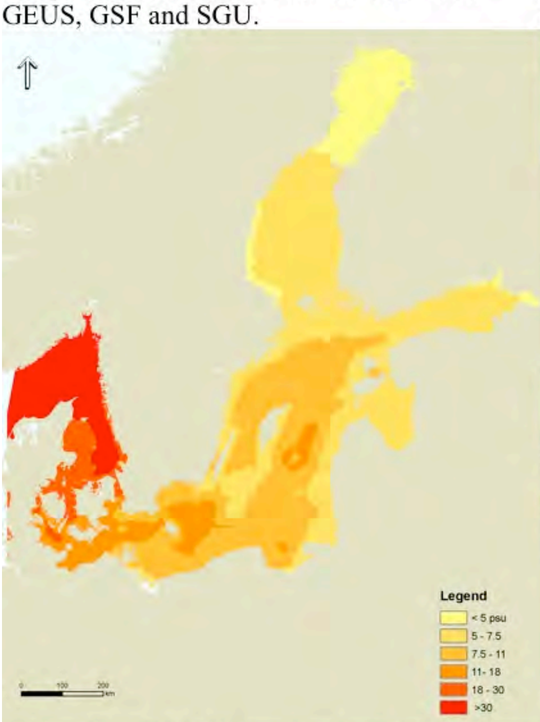


Figure 2.1.1c. Model results showing the bottom salinity (psu) field over the Baltic Sea. Data source: NERI.

Figure 2.1.1d. Benthic marine landscape map of the Baltic Sea. Source: BALANCE, see Al-hamdani & Reker 2007 for details.

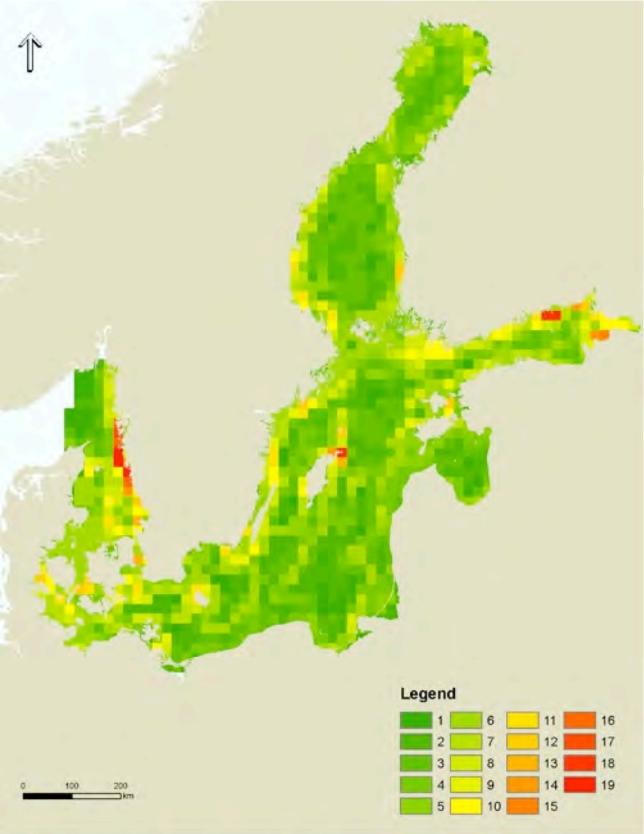


Figure 2.2.2 Map showing the number of benthic marine landscapes within a 20km grid.

2.1 BOXES

Box 2.1.1. Timeline

2000 – Marine landscape concept presented for Canadian waters

2004 – Marine landscapes developed for the Irish Sea

2007 – Marine landscapes developed for UK waters

Aug. 2007 – Marine landscapes developed for an entire Marine Region including territorial waters from 9 independent States - the Baltic Sea Marine Region. See www.balance-eu.org for more information

Okt. 2007 – First time marine landscapes are recognized in an international agreement – the HELCOM Baltic Sea Action Plan

Nov. 2008 – Marine landscape maps available at www.HELCOM.fi

Box 2.1.2. The Baltic marine landscapes

60 benthic marine landscapes identified for the Baltic Sea;

The marine landscape, non-photic mud at 7,5 – 11psu cover more 58.000 km^2;

Marine landscapes cover 371.000 km^2 or more than 90% of the Baltic seafloor;

40 marine landscapes cover less than 1% of total seafloor area;

Species composition varies significantly between individual landscapes (where tested).

2.2 Habitats

The term habitat is defined by ICES (2006) as "a particular environment which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular but dynamic spatial and temporal scales in a recognizable geographic area". Within HELCOM, the term biotope is often used in the same sense as habitat.

The Baltic Sea Action Plan includes the following target related to habitats and biotopes: "*By 2010 to halt the degradation of threatened and/or declining marine biotopes/habitats in the Baltic Sea, and by 2021 to ensure that threatened and/or declining marine biotopes/habitats in the Baltic Sea have largely recovered"*. At this time, there is no long-term data available allowing an analysis of trends in the status of the habitats of the Baltic Sea. This section provides and overview of threat status and conservation status of Baltic Sea marine habitats as reported to HELCOM and the EC commission.

2.2.1 Conservation and Threat Status of Habitats/Biotopes

In 1998 HELCOM published the Red List of Marine and Coastal Biotopes of the Baltic Sea (HELCOM 1998) as the result of an HELCOM project with experts from all Contracting States. Based on a comprehensive classification of marine and coastal biotopes, it was the first threat assessment of all marine and coastal biotopes for an entire regional sea area in the world. The experts assigned one of five fixed threat categories to every biotope as well as those adverse human impacts which caused the threat or decline. The reported threat status gave cause for concern: 83% of the biotopes were either assessed as "heavily endangered" (15%) or "endangered" (68%).

With respect to adverse human impacts, the following can be highlighted. All coastal and marine biotopes of the Baltic Sea area were assessed as threatened by different kinds of pollution and in particular, most biotopes were affected by eutrophication. Among other factors agriculture, industry and traffic were identified as important sources of eutrophication and pollution. Also different marine construction activities, dredging and dumping of dredged material and some fishery practices and mariculture were reported to have heavy but primarily local negative impacts on pelagic and especially benthic biotopes. Further it was assessed that coastal defence measures often hinder or even interrupt the complex interactions of coastal dynamics by e.g. preventing beaches as well as cliffs from being abraded, which results in an obstruction of sand supply for necessary beach nourishment elsewhere. In most Baltic Sea regions building activities for recreational purposes such as large camping grounds, marinas, summer houses or hotel complexes at or near the beach but also constructions of harbours and ship yards have caused problems, and regularly resulting in permanent direct destruction or fragmentation of biotopes (see also HELCOM 1998, Figure 18). With HELCOM Recommendation 21/4[1] Contracting Parties committed themselves to legally protect the most threatened biotopes of the red list.

In addition to the HELCOM Red list, this chapter uses as background material also the HELCOM List of Threatened and/or Declining Species and Biotopes/Habitats in the Baltic Sea area (hereafter the HELCOM List, HELCOM 2007), and the 2001-2007 reports on the conservation status of the Natura 2000 habitats from Baltic Sea EU Medunlinmber States (MS) to the EU Commission according to Article 17 Habitats Directive.

Habitat by habitat assessment

The HELCOM List (HELCOM 2007) forms the core of the assessment. It includes inter alia all marine Natura 2000 natural habitat types as in Annex 1 of the EU Habitats Directive. The first comprehensive reporting of Baltic Sea MS on the conservation status of Natura 2000 natural marine habitat types to the EU Commission is summarised in Table 2.2.1. According to the Habitats Directive the status of a habitat can be favourable when (1) its natural range and areas it covers within that range are stable or increasing, and (2) the specific structure

1 Protection of Heavily Endangered or Immediately Threatened Marine and Coastal Biotopes in the Baltic Sea Area (Adopted 20 March 2000).

and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and (3) the conservation status of its typical species is favourable.

In the same table, these results are compared to the threat assessments given in the HELCOM Red List of Biotopes (HELCOM 1998). The most important results of the assessment according to Table 2.1.1 are:

Sandbanks: The conservation status is favourable in three MS, inadequate in two and bad and unknown in one, respectively. In one country, according to the national reporting and HELCOM (1998), this natural habitat type is not present. The threat situation for all Baltic Sea states (including Russia) is as follows: Heavily endangered in one state, endangered in four, and in one case between endangered and heavily endangered (2-3). According to HELCOM (2007) sandbanks are widely spread throughout the whole Baltic Sea area, and occur in all HELCOM sub-regions. They are threatened and/or declining mainly in the southern Baltic Sea area.

Estuaries: The conservation status is favourable in three MS, inadequate and bad in two, respectively. In one country, according to national reporting, this natural habitat type is not present. The threat situation for all Baltic Sea states (including Russia) is as follows: Heavily endangered in four states, endangered in five. In one case the threat category is between endangered and heavily endangered (2-3). According to HELCOM (2007) estuaries are present around the whole Baltic Sea area, and occur in all HELCOM sub-regions. They are threatened and/or declining in many sub-regions of the Baltic Sea area.

Mudflats and Sandflats: The conservation status is favourable in one MS, inadequate in two, and bad in one. In four countries, according to national reports, this natural habitat type is not present. The threat situation for all Baltic Sea states (including Russia) is as follows: Endangered in seven countries and Potentially Endangered in one. In one case the threat category is between endangered and heavily endangered (2-3). According to HELCOM (2007), mudflats and sandflats are widely spread throughout the whole Baltic Sea area, and occur in all HELCOM sub-regions. They are threatened and/or declining in almost all sub-regions of the Baltic Sea area.

Coastal lagoons: For HELCOM, the respective biotope complex includes several specific types of lagoons such as some sub-types of Bodden, Barrier Lagoons and Fladas. The biotope type Coastal lake (HELCOM 1998) belongs also to coastal lagoon complex. The threat situation for all Baltic Sea states (including Russia) is as follows:

Biotope complex Lagoons: Heavily Endangered in five countries, Endangered in three and Potentially Endangered in one. In one case the threat category is between Endangered and Heavily Endangered (2-3). In the Russian part of the Gulf of Finland, this biotope complex is presumably Not Endangered at present;

Biotope type Coastal Lakes: Immediately Threatened in one country, Heavily Endangered in one, and Potentially Endangered in six. In one case this biotope type is presumably Not Endangered at present. According to HELCOM (2007), lagoons are widely spread throughout the whole Baltic Sea area, and occur in all HELCOM sub-regions. They are threatened and/or declining in all sub-regions Baltic Sea area;

The conservation status of the Natura 2000 natural habitat type "Coastal Lagoons" is favourable in three MS, inadequate in two, and bad in three. It is the only Baltic Sea marine priority habitat within the EU. They are in immediate threat to become completely changed from an EU-wide perspective, and therefore enjoy a strict EU protection regime.

Large shallow inlets and bays: The conservation status is favourable in one MS, inadequate in four, and bad in one. In two countries, according to national reports, this natural habitat type is not present. Put side by side with HELCOM biotopes, it cannot be exactly matched to biotopes of the HELCOM red list. From the HELCOM biotope complexes, only fjards/fjord like bays fit into this natural habitat type as well as some types of Bodden, and their appearance is restricted to the southern part of the Baltic Sea area. The threat situation for all Baltic Sea states (including Russia) is as follows (HELCOM 1998): Heavily endangered in one country, endangered in three. According to HELCOM (2007) this habitat type is, however, present around the whole Baltic Sea area, and occurs in all HELCOM sub-regions. It is threatened and/or declining along many central and southern Baltic Sea coasts.

Reefs: The conservation status of Reefs is favourable in four MS, inadequate in one, bad in two and unknown in one. The threat situation for all Baltic Sea states (including Russia) is as follows: Heavily endangered in one state, endangered in five, and in one case, presumably Not Endangered at present. According to HELCOM (2007), reefs are widely spread throughout the whole Baltic Sea area, and occur in all HELCOM sub-regions. They are threatened and/or declining mainly in the southern Baltic Sea area.

Submarine structures made by leaking gases are only reported as sub-type "Bubbling Reefs" in Danish waters of the Kattegat. The conservation status is bad. The HELCOM (1998) threat category is between endangered and heavily endangered (2-3). Although, according to HELCOM (2007), submarine structures made by leaking gases appear only in the Kattegat sub-region of the Baltic Sea area, the other sub-type of this Natura 2000 natural habitat type – Pockmarks – may be more widely spread in the Baltic Sea area. This needs to be scrutinized by EU MS.

Baltic esker islands are only reported from Finland (inadequate) and Sweden (favourable). For the implementation of the EU Habitats Directive they are only assessed in the EU Boreal Region. According to HELCOM (1998) they also appear in the marine areas of other Baltic Sea states, but status has not been assessed in these cases.

Boreal Baltic narrow inlets are only reported from Finland and Sweden. In both cases the conservation status is inadequate. For the implementation of the EU Habitats Directive they are only assessed in the EU Boreal Region. According to HELCOM (1998) they are assessed as Endangered in Finland and Sweden, respectively.

Country by country assessment

In Estonia, Latvia and Lithuania, the conservation status of all reported Natura 2000 habitat types is favourable. In Denmark, Finland, Germany and Sweden, the conservation status is predominantly non-favourable (one favourable in Denmark and Sweden and two unknown in Germany). In Poland the conservation status of reported natural habitat types is inadequate in three and favourable in two habitat types.

For Russia, it is only possible to consider the HELCOM Red List of Biotopes, because the Russian Federation is not an EU MS. The threat categories for most biotope types and complexes in Russian waters in and off the Kaliningrad oblast are between endangered and heavily endangered (2-3), whereas in the Gulf of Finland many are presumably Not Endangered at present.

In conclusion, the conservation status of the natural habitat types as in the HELCOM List and in Annex 1 (Habitats Directive) is assessed very differently by HELCOM EU MS. Table 2.2.1 makes it clear that some countries judge habitat types as being in a favourable conservation status even though they are threatened according to the HELCOM List of Biotopes. Moreover, it is obvious that some HELCOM EU countries have reported some natural habitat types as being not present in their marine or coastal area to the EU Commission, although they were assessed as being threatened in their country (HELCOM 1998).

Assessment of other habitats/biotopes

In addition to the above Natura 2000 natural habitat types, the HELCOM List (HELCOM 2007) includes habitat/biotope types: (1) Offshore (deep) waters below the halocline, (2) Shell gravel bottoms, (3) Seagrass beds, (4) Macrophyte meadows and beds, (5) Gravel bottoms with Ophelia species, (6) Maerl beds, and (7) Sea pens with burrowing megafauna.

Offshore (deep) waters below the halocline occur in all main basins of the Baltic Sea area. They are threatened where they appear and are assessed for the whole area as Heavily Endangered (HELCOM 1998). Also seagrass beds with *Zostera marina* occur in the entire Baltic Sea area, but not as far north as the Bothnian Sea, whereas seagrass beds with *Zostera noltii* are restricted to the western and southern parts of the Baltic Sea area including the Bay of Mecklenburg and the Gulf of Gdansk. Seagrass beds belong to the most threatened marine biotopes in the Baltic Sea area. They are part of the Heavily Endangered HELCOM biotope type “Level sandy bottoms dominated by macrophyte vegetation" (HELCOM 1998). Macrophyte meadows and beds (other than seagrass beds) occur on soft and hard bottoms in the whole Baltic Sea area (HELCOM 2007). From a Baltic-wide perspective the exact status of threat and/or decline is not known yet. However the biotope is threatened and declining where it appears, because characteristic species are not recorded at the same water depths as before. They are part of many Endangered or Heavily Endangered HELCOM biotope types which are dominated by macrophyte vegetation (HELCOM 1998).

In the southern and western parts of the Baltic Sea, there are habitat types characterised by species requiring more saline waters. Shell gravel bottoms, Maerl beds, Gravel bottoms with Ophelia species, and Sea pens and burrowing megafauna communities are all very rare. Although they are threatened where they appear (HELCOM 2007), their status of threat and/or decline is not exactly known yet. These biotopes are however considered to occur in limited areas, and be therefore Potentially Endangered. Maerl beds occur only on offshore banks in the Kattegat (e.g. Lilla Middelgrund and Fladen). The presence of dead maerl at some offshore banks indicates that the habitat must have been more widespread in the past (see OSPAR 2006). Sea pens and burrowing megafauna communities are found only in the deeper parts of the Kattegat (HELCOM 2007).

2.2.2 Conclusions

Although the biotopes/habitats in the HELCOM list are all to a certain degree threatened and/or declining, this is not necessarily the case in all sub-regions of the Baltic Sea area or in all Baltic maritime areas of HELCOM Contracting States. The exact status of threat and/or decline is not always known, but the above assessment makes it clear that from a Baltic-wide perspective, none of the habitats/biotopes, assessed by HELCOM can be considered as being in a favourable conservation status. For most of them the conservation status is inadequate or even bad and they are all in urgent need of protective measures (HELCOM 2007). According to the HELCOM Red list of biotopes (HELCOM 1998) the situation is worrying in particular for biotope complexes such as offshore (deep) waters below the halocline, lagoons and estuaries, as well as for some benthic biotope types like seagrass beds and macrophyte meadows and beds. Additionally, all habitats/biotopes which are Potentially Endangered have always been rare or exist only in a small distribution area. Therefore, they are continuously in potential danger of becoming destroyed (HELCOM 1998).

The HELCOM Baltic Sea Action Plan (BSAP) calls for a favourable status of marine biodiversity. In order to reach the target of the BSAP related to habitats and biotopes there are urgent needs for actions to protect and restore them. As the first step and in order to increase knowledge, the BSAP arrogates that by 2013 the HELCOM Red List of Biotopes (HELCOM 1998) must be updated. Periodic updates of this List will in the future make it possible assess trends in the threat status and thus to evaluate whether the target to halt the degradation and ensure recovery of threatened and/or declining marine biotopes/habitats in the Baltic Sea is fulfilled.

This assessment shows that there are a couple of needs for scrutinizing and clarification, e.g. why have some Baltic Sea EU MS not reported Natura 2000 natural habitat types to the EU Commission, although they are obviously present in their Baltic Sea marine area or why is there not enough knowledge to assess the conservation status of some marine biotopes/habitats. Moreover, why some red-listed biotope types or complexes (HELCOM 1998) seemed to be contradictorily reported as being of favourable conservation status to the EU Commission.

Table 2.2.1. Conservation status of the Baltic Sea marine Natura 2000 habitats in comparison to HELCOM threat assessment (HELCOM 1998).

N2k-Code	Natural Habitat Type	Denmark		Estonia		Finland		Germany		Latvia		Lithuania		Poland		Russia	Sweden		HEL
		N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	HEL	N2K	HEL	Baltic-wide
1110 MAR	Sandbanks which are slightly covered by sea water all the time	U2	3	FV	3	U1	3	XX	2	FV				FV	3	2-3	U1	3	3 Codes: 2.4.2.3, 2.5.2.4
1130 BOR	Estuaries			FV	3	U2	3				2	FV	3		3	2	U1	2	2
1130 CON	Estuaries	FV	3					U2	2					U1		2-3	U1		Codes: I,J (complex)
1140 BOR	Mudflats and sandflats not covered by seawater at low tide			FV	3		3				3		P			3	U1		3
1140 CON	Mudflats and sandflats not covered by seawater at low tide	U2	3					U1	3						3	2-3	U1		Codes: 2.5.3.3, 2.5.3.2, 2.7.3.1, 2.7.3.2
1150 BOR	Coastal lagoons			FV	3/P	U1	2/2			FV	2/1	FV	2/P			ρ	U2	3/ρ	2/P Codes: G (complex)/
1150 CON	Coastal lagoons	U2	3/P					U2	2/P					U1	2/P	2-3/P	U2		4.1.1.1, 4.1.1.2, 4.1.2.1, 4.1.2.2, 4.1.2.3, 4.1.3.1, 4.1.3.2
1160 BOR	Large shallow inlets and bays			FV		U1	3									3	U1		3
1160 CON	Large shallow inlets and bays	U2	3					U1	2					U1			U1		Codes: F (complex)
1170 MAR	Reefs	U2	3	FV	3	U1	3	XX	2	FV	3	FV		FV		ρ	U2	3	3 Codes: 2.1.1.2.3, 2.1.1.3.3, 2.1.2.2.3, 2.1.2.3.3, 2.2.2.3, 2.2.3.3

1180 MAR	Submarine structures made by leaking gases	U2 2-3									**P** Codes: 2.10.2.1, 2.10.2.2
1610 BOR	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	P		U1 2					ρ	FV 3	**3** Codes: M (complex)
1650 BOR	Boreal Baltic narrow inlets			U1 3						U1 3	**3** Codes: E (complex)

Abbreviations used in the table:

a. in relation to Natura 2000

N2K: Natura 2000, **FV**: Favourable- / **U1**: Inadequate- / **U2**: Bad- / **XX**: Unknown conservation status

CON: Continental Biogeographic Region of the EU; **BOR:** Boreal Biogeographic Region of the EU; According to the biogeographic regions of the EU, Baltic Sea EU members belong either to the Continental Region (Denmark, Germany, Poland), to the Boreal Region (Estonia, Finland, Latvia, Lithuania) or are assigned to both (Sweden). Russia, as non EU state, would belong with her St. Petersburg area to the Boreal Region and with the Kaliningrad oblast to the Continental Region.

MAR: These habitat types are in this case assessed for the entire Baltic Sea area, because they were not as clearly defined as the other habitats and therefore were subject to a scientific reservation by the Habitats Committee of the EU. Meanwhile new definitions exist (European Commission 2007).

b. in relation to HELCOM

HEL: Threat assessments according to the HELCOM Red List of Biotopes (HELCOM 1998).

Codes: refer to codes biotope types (numbers) or biotope complexex (letters) in HELCOM (1998).

Threat Categories according to HELCOM (1998): **0 -** Completely destroyed, **1** - Immediately threatened, **2** - Heavily endangered, **3** – Endangered, **P** - Potentially endangered, **ρ** - Presumably not endangered at present.

CHAPTER 3: COMMUNITIES

Communities are assemblages of species within an ecosystem. The composition of species within a community influences fundamental processes such as the productivity, stability and trophic interactions within the food web and thereby also the overall functioning of the ecosystem. The communities specifically addressed in this chapter are the Baltic phytoplankton, habitat forming species, zooplankton, benthic invertebrates and fish. The different communities form an intricate web with predatory, competitive, synergistic and commensalistic interactions. Thus, changes in one community therefore inevitably affect other components of the Baltic biodiversity (Figure 3.1).

Except for the habitat forming species, there are no targets of the Baltic Sea Action Plan (BSAP) that are directly linked to the communities of the Baltic Sea. However, due to their fundamental role in the ecosystem, assessment of the composition as well as of key species of the communities provide a central component for determining the conservation status the Baltic Sea.

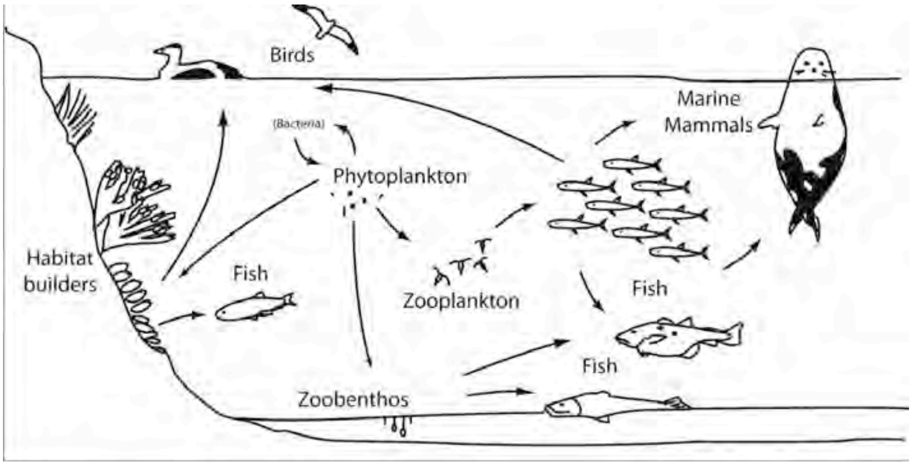


Figure 3.1. DRAFT Food web illustration depicting the links between Baltic Sea communities.

3.1 Phytoplankton communities

The Baltic Sea phytoplankton community is a diverse mixture of microscopic algae representing several taxonomic groups and more than 1 700 species have been recorded (Hällfors, 2004). The phytoplankton composition in different sub-basins of the Baltic Sea depends among other things on the salinity (Carstensen et al. 2004; Wasmund & Siegel 2008). Diatoms and dinoflagellates are characteristic in the saline waters of the southern Baltic Sea, the Belt Sea and the Kattegat, whereas phytoplankton groups preferring less saline water, such as cyanobacteria and chlorophytes, are commonly found in the northern Baltic Sea. The geographic distribution pattern complicates the use of certain phytoplankton groups as Baltic-wide indicators of the ecological state (Carstensen et al. 2004; Gasiūnaitė et al. 2005).

Phytoplankton are dominant primary producers both in the coastal and open Baltic Sea, and serve as energy source for the higher components of the food web. The socio-economic importance of phytoplankton is largely connected to the negative impact of algal blooms and their potential toxicity (HELCOM, 2006). Algal blooms decrease water transparency and light availability, which in turn affect submerged vegetation in the coastal areas. In addition, blooms increase sedimentation of organic material, which, in turn, increases oxygen consumption in the near bottom waters and induces internal nutrient loading (HELCOM 2002). Dense and potentially toxic blooms reduce the recreational use of the water, pose a health risk, and have economical implications e.g. to fishing (GEOHAB, 2001). The blooms of toxic phytoplankton species can also inhibit the growth and reproduction of other aquatic organisms (Karjalainen et al. 2007; Uronen, 2007).

Phytoplankton are generally addressed in the Baltic Sea Action Plan (BSAP) by the target *"By 2021 all elements of the marine food webs, to the extent that they are known, should occur at natural and robust abundance and diversity"*. In its Eutrophication segment, the BSAP also includes the ecological objective *"Natural level of algal blooms"*. Algal blooms implicate reduced biodiversity of phytoplankton community and also pose a risk to other components of biodiversity in the Baltic Sea ecosystem (cf. Uronen, 2007, and references therein). It has been recently shown that phytoplankton biodiversity increases resource use efficiency and stabilizes species composition and thus decrease the potential risk for algal species invasions and/or resource monopolization e.g. by algal blooms (Ptacnik et al. 2008).

3.1.1 Status and trends

Nutrients and light control the growth of phytoplankton, but also other factors, such as water temperature, stratification, mixing conditions and grazing, influence the biomass and species composition (Wasmund & Siegel, 2008). Phytoplankton communities in the Baltic Sea area therefore reflect hydrological changes as well as the eutrophication process (e.g. Wasmund & Uhlig, 2003; Suikkanen et al. 2007). Increased nutrient concentrations increase the bloom frequency and duration, and together with changes in the ratios of nitrogen, phosphorus and silicate they also modify the species composition (Yurkovskis et al. 1999; Carstensen & Heiskanen, 2007).

Phytoplankton respond rapidly to changes in environmental conditions, and can therefore be used to assess the ecological status of the water. To assess changes in the phytoplankton community and to detect long-term trends, indicators based on species composition and group dominance are predominantly used since traditional measures of diversity (e.g. richness and evenness) or chlorophyll (as a proxy of biomass) do not necessarily display the change from one community to another.

This assessment concentrates on a number of preliminary indicators that are typically sensitive to eutrophication and nutrient loading (HELCOM, 2006; Fleming-Lehtinen, 2007); the ratio between diatoms and dinoflagellates in spring, the frequency and intensity of cyanobacterial blooms in summer, especially the biomass of the cyanobacterium *Aphanizomenon flos-aquae*, and the biomass of the dinoflagellate genus *Dinophysis*. The results are based on time series data of 20-30 years, depending on the indicator, covering the major basins and some coastal areas. With the exception of *Aphanizomenon* reference conditions have not yet been determined for these phytoplankton indicators (HELCOM, 2006; Kuuppo, 2007) and they are thus not used in the pilot testing of the Biodiversity Assessment Tool BEAT (chapter 5). However, for smaller regions, historical literature may be used to define reference conditions, as shown by Wasmund et al. (2008) for the Kiel Bight.

Diatom/Dinoflagellate ratio in spring

The phytoplankton spring bloom is usually a short-term event that occurs annually in the Baltic Sea area. The bloom succession and intensity are closely linked to the nutrient availability, although light, water column mixing and the timing of ice melting are also of importance (e.g. Yurkovskis et al. 1999; Wasmund & Siegel, 2008).

The spring bloom in the Baltic Sea is dominated by diatoms and dinoflagellates (HELCOM 1996; 2002). Long-term data from the Baltic Proper suggest that dinoflagellates are becoming more abundant in spring (Figure 3.1.1, Wasmund & Siegel, 2008). The reason for the increased importance of dinoflagellates is not clear, but it may be linked to changes in climatic conditions and stratification patterns (Tamelander & Heiskanen, 2004; Wasmund et al. 1998; Toming & Jaanus, 2007).

The shift from diatoms to dinoflagellates may have implications for the nutrient dynamics in the summer and input of organic matter to the sediment as diatoms usually sediment to the sea bed at the end of the bloom, whereas the dinoflagellates are mostly remineralized already in the upper water layers (Tamelander & Heiskanen, 2004). A general decrease in diatoms has, however, not been found in the Belt Sea up to now as confirmed by Wasmund et al. (2008) for the Kiel Bight for the last 100 years.

The spring bloom intensity, based on the high-frequency monitoring data of chlorophyll-a collected on merchant ships, has been monitored since 1992 in the Arkona Basin, the Northern Baltic Proper and the Western Gulf of Finland (Fleming & Kaitala, 2006). The index values of 0-1060 from the period 2000-2006 are comparable to previous years and do not indicate any clear trends, although the average values have been slightly higher in the 2000s, in particular in the Gulf of Finland (Figure 3.1.2; Fleming & Kaitala, 2006).

Cyanobacterial blooms

Cyanobacteria are a natural component of most parts of the Baltic Sea area phytoplankton (HELCOM, 1996; Finni et al. 2001; Hajdu et al. 2008). They usually dominate in the coastal and open areas of most sub-basins of the Baltic Sea in summer, with the exception of the Belt Sea and the Kattegat (e.g. Jaanus et al. 2007; Wasmund & Siegel, 2008). Cyanobacterial blooms in the Baltic Proper are typically formed by the diazotrophic species

Aphanizomenon flos-aquae, *Anabaena* spp. and *Nodularia spumigena*, that can fix molecular nitrogen (Laamanen & Kuosa, 2005; Mazur-Marzec et al. 2006; Hajdu et. al. 2007). *N. spumigena* blooms are potentially toxic (e.g. Karjalainen et al. 2007), whereas no toxic blooms of *A. flos-aquae* have been recorded in the Baltic Sea. The blooms of N_2-fixing cyanobacteria as such do not necessarily indicate strengthened eutrophication (Gasiūnaitė et al. 2005; Toming & Jaanus, 2007).

Satellite images covering the Baltic Sea area show that the frequency and magnitude of the accumulation of cyanobacteria on the surface water have varied during 1997-2007, but without a clear trend (Figure 3.1.3, Hansson, 2007). However, the average frequency of cyanobacterial accumulations was 39% higher in 1998-2006 than in 1979-1984, albeit the difference is not significant (Kahru et al. 2007). It should be noted that satellite images describe relatively well the surface accumulation of *N. spumigena*, but mostly ignore *Aphanizomenon* which generally locates deeper in the water column (Kahru et al. 2007).

The surface blooms are typically short in duration, i.e. from days to few weeks (Hansson, 2007), but their influence may last longer through the effects on near bottom oxygen conditions and potential food web effects (Karjalainen et al. 2007; Vahtera 2007). Low nitrogen to phosphorus ratio and calm and warm weather typically favour the surface accumulation of cyanobacteria (Wasmund & Siegel, 2008).

The cyanobacterial biomass has been lower in the 2000s than in the 1980s-1990s in the Gulf of Riga, Eastern Gotland Basin and Arkona Basin (Jaanus et al. 2007). Contrary to this, late-summer biomass of cyanobacteria has been reported to increased in the open northern Baltic Sea since the late 1970s (Suikkanen et al. 2007; see also Kahru et al. 2007).

The cyanobacteria bloom index integrates the rank abundance of *A. flos-aquae* and *N. spumigena* during the growing season (April-October) along the ferry route sampling points between Helsinki and Travemünde (Kaitala & Hällfors, 2007). The value of the bloom index has been at the same level in 2001-2006, but it was above the mean of 1997-2006 in 1999 and 2000 and lower in 1997-1998.

A. flos-aquae has been reported to increase in the surface water (0-10 m) in the open and coastal Gulf of Finland in 1968-2004, which can be linked to strong internal nutrient loading in the area (Fleming-Lehtinen, 2007; Suikkanen et al. 2007). *A. flos-aquae* has also increased since 2003 in the coastal areas of Askö (Hajdu et al. 2007). However, the long-term change in *A. flos-aquae* biomass is not evident in all sub-basins of the Baltic Sea in the 1980s-2000s (Figure 3.1.4): e.g. in the southern Baltic Sea area the *Aphanizomenon* biomass has been lower in the 2000s.

Nodularia spumigena has been reported to increase in the open northern Baltic Proper in summer (Suikkanen et al., 2007; Hajdu et al. 2007). In the coastal waters of the Gulf of Gdańsk, intensive blooms of *N. spumigena* has been recorded frequently since 1994, and the highest *Nodularia* blooms have occurred in 1994, 2001, 2003 and 2004 (Mazur-Marzek, 2006).

The dinoflagellate *Dinophysis*

The toxic dinoflagellate genus *Dinophysis* is suggested to reflect increased nutrient status and climate induced changes in salinity and mixing conditions (Godhe et al. 2002). It has been shown that the toxins of e.g. *Dinophysis acuminata* can be transferred in the pelagic food chain (Sopanen et al., in prep.), and sediment to the benthic ecosystem (Kuuppo et al. 2006). The effects of the *Dinophysis* species on the ecosystem are however unclear.

A comparative study from the western Gulf of Finland and the northern Baltic Proper with data from 1903-1911 and 1993-2005 showed that *Dinophysis acuminata*, *D. norvegica* and *D. rotundata* occur more frequently today than in the beginning of the 20th century (Hällfors et al. 2008). However, the results from the last 30 years show that of the studied sub-basins, the spring and summer biomass of the *Dinophysis* species has been lower in 2000s than in the 1980s-1990s in the Arkona Basin, the Bornholm Basin, the Bay of Mecklenburg and the Eastern Gotland Basin (data not shown). For example, the biomass of the *Dinophysis norvegica* has decreased significantly since 1990s in the Landsortdeep and in the coastal area (Askö) in the Northern Baltic Proper (Hajdu et al. 2007). In the Gulf of Finland and the Bothnian Bay the *Dinophysis* biomass in summer has remained rather similar in the 1990s and 2000s. *Dinophysis* species occur frequently in the inner and outer Kattegat and the inner Skagerrak, and their abundance in these areas is mostly connected to stratification conditions (Håkansson, 2007).

Unusual events and new species invasions

Unusual events in the phytoplankton community of the Baltic Sea are linked to hydrology, invasion of alien species, immense loading of nutrients and extreme weather events (Hajdu et al. 2006). During the 2000s the potentially toxic dinoflagellate, *Alexandrium ostenfeldii*, has developed larger populations than noticed before, and blooms have been recorded in the Gulf of Gdańsk and the Swedish east coast of the northern Baltic Proper (Hajdu et al. 2006). *A. ostenfeldii* has previously mainly occupied the Kattegat and the southern Baltic Proper (e.g. Håkansson, 2007). Another toxic dinoflagellate, *Prorocentrum minimum*, is also establishing in the Baltic coastal areas (Hajdu et al. 2005). *P. minimum* has however not been recorded in masses in the Northern Baltic Proper and the Gulf of Finland after 2003. The step-wise pattern of the invasion of the species supports the natural transport theory and adaptation to new environment.

The blooms of the toxic raphidophyte *Verrucophora* spp. (named earlier as *Chattonella*) have occurred in the Skagerrak-Kattegat area in 2000, 2001, 2004 and 2006. *Verrucophora* is a new problem genus in the area and has caused damage to wild and farmed fish (Håkansson, 2007). Mass occurrences of phytoplankton species (e.g. the dinoflagellate *Gyrodinium aureolum* in 1982; the toxic haptophyte *Chrysochromulina polylepis* in May-June 1988; the toxic diatom *Pseudo-nitzschia pseudodelicatissima* in autumn 1999) in the Skagerrak and the Kattegat area have been related to intrusions of nutrient rich water into the pycnocline (e.g. Håkansson 2007). Accordingly, it has been proposed that many recent changes in the phytoplankton could be related to climatic variation and climate change which influence directly and indirectly e.g. water temperature, salinity, and loading from the catchment in the Baltic Sea area (e.g. Hajdu et al. 2007).

Analysis of historical and present day phytoplankton composition data shows that many phytoplankton taxa are nowadays more frequent, and their seasonal dynamics have changed compared to the situation in the early 1900s (Hällfors et al. 2008; Wasmund et al. 2008). In addition to cyanobacteria (e.g. Hajdu et al. 2007), long-term records provide evidence that the biomass of chrysophytes and chlorophytes in the surface water has increased significantly in the open northern Baltic Sea (Suikkanen et al. 2007). In the coastal waters the shifts in the phytoplankton composition are typically not abrupt and the changes are rather small if the increases in nutrient levels are small or moderate (Carstensen & Heiskanen, 2007).

3.1.2 Conclusions

Long-term data sets (Hällfors et al. 2008; Wasmund et al. 2008) indicate that the phytoplankton species composition has experienced changes during the last 100 years in parts of the Baltic Sea. Albeit clear trends are largely missing from the last decades, the reported long-term increases in cyanobacteria and the blooms of problem species propose that the Baltic Sea phytoplankton is not at its "natural level" as targeted in BSAP. At present, enhanced internal loading of phosphorus and the removal of dissolved inorganic nitrogen, e.g. by denitrification and anammox, leads to lower nitrogen to phosphorus ratios, which favor the blooms of N_2-fixing cyanobacteria (Vahtera et al. 2007). This complicates the target for short-term reduction of present blooms.

The establishment of new species and observed changes in the species composition indicate changes in phytoplankton biodiversity. However, the reasons behind the biodiversity changes are not fully understood. Thus, the preliminary indicators used in this assessment and other phytoplankton data should be further evaluated so that the causes behind observed changes can be better distinguished. Also the effects of the biodiversity changes on the Baltic Sea ecosystem cannot yet be determined. The changing climate, with e.g. a higher probability to extreme weather events, is likely to increase a risk for new species introductions and unexpected blooms in the Baltic Sea area.

3.1.3 Recommendations

Sustaining phytoplankton biodiversity in the Baltic Sea and reaching the targets of the Action Plan related to phytoplankton are linked to the reduction of eutrophication, and minimizing the introduction of new harmful species to the Baltic Sea by ballast waters.

The detection of possible changes in the phytoplankton communities necessitates a long-lasting and representative biological monitoring program in all sub-basins of the Baltic Sea, the use of up-to-date monitoring methods, and quality assured species identification at high taxonomic resolution.

3.1 FIGURES

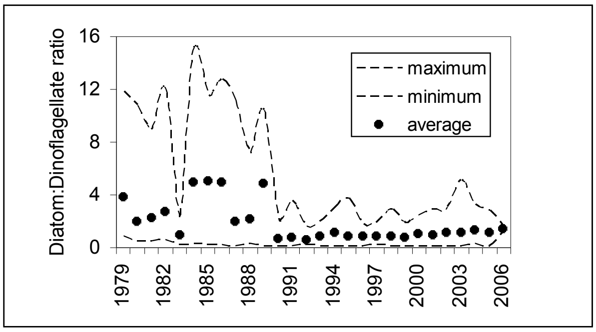


Figure 3.1.1. Mean, maximum and minimum diatom to dinoflagellate biomass ratios in February-May in the southern and central Baltic Proper. The dinoflagellate biomass includes all auto- and mixotrophic species, but excludes heterotrophs. HELCOM BMP station data.

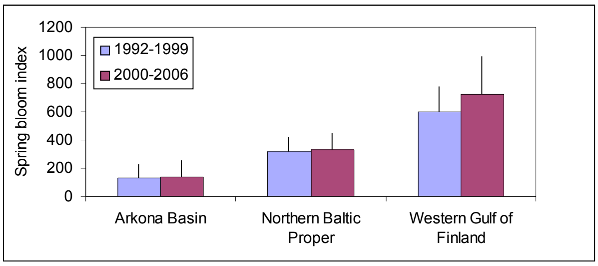


Figure 3.1.2. Phytoplankton spring bloom index in the open Gulf of Finland, Northern Baltic Proper and Arkona Basin. The bars represent average values with standard deviations for the periods 1992-1999 and 2000-2006. Alg@Line data modified from Fleming and Kaitala (2006).

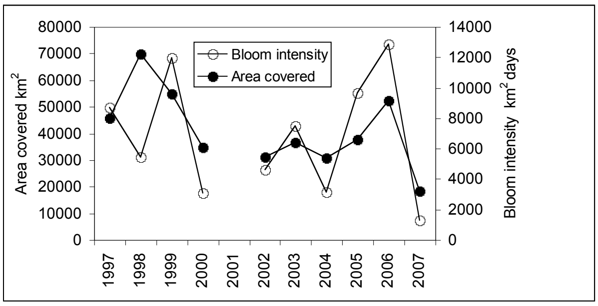


Figure 3.1.3. Areal coverage and intensity of the cyanobacterial blooms as integrated for the entire Baltic Sea area in 1997-2007. Yearly summary values are based on the analysis of satellite image data. Modified from Hansson (2007).

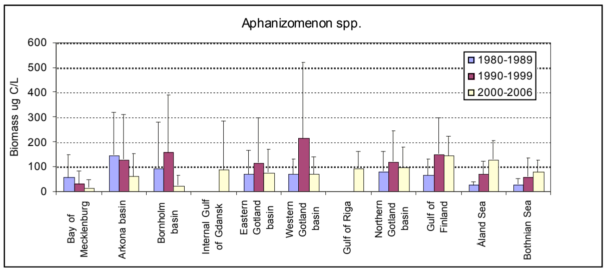


Figure 3.1.4. Mean biomass of the cyanobacterium *Aphanizomenon* spp. in June-September in the 1980s, 1990s and 2000s in different parts of the open and coastal Baltic Sea. The whiskers show the standard deviation. HELCOM BMP station data.

3.2 Habitat forming species

The Baltic Sea, being a waterbody with harsh environmental conditions and steep environmental gradients, provides home for a variety of benthic species. A quite small number of species have a special role in the ecosystem providing with their physical structure or physiological performance the necessary environmental support for other species. These species are able to physically modify the environment and structure the habitat to provide suitable conditions for a large number of species. In the Baltic Sea such special, keystone species are usually large perennial macroalgae on hard bottoms and phanerogams and charophytes on soft bottoms. In sea bottom areas without access to direct sunlight mussels become the structuring component for main habitat characteristics. These species are extremely important for the functioning of the whole Baltic Sea ecosystem and for maintaining the benthic biodiversity.

The importance of these species for maintaining a healthy status of the Baltic Sea is also recognised in the Baltic Sea Action Plan where several environmental targets are set and actions are designed to preserve the favourable status of these species and communities e.g. *"By 2021, that the spatial distribution, abundance and quality of the characteristic habitat-forming species, specific for each Baltic Sea sub-region, extends close to its natural range"*. Several habitat forming species are also declining in certain areas of the Baltic and are therefore embraced by the target "By 2010 to halt the degradation of threatened and/or declining marine biotopes/habitats in the Baltic Sea, and by 2021 to ensure that [they] have largely recovered".

3.2.1 Status and trends

Fucus vesiculosus (bladder wrack)

Fucus vesiculosus is often characterised as the most important of all phytobenthic species in the Baltic coastal zone. This is due to its wide distribution and high biomass and productivity along rocky and stony coasts where *Fucus* belts play an important structuring role and have a positive effect on biodiversity, being habitats for species-rich epiphytic and epibenthic communities (Figure 3.2.1) (e.g.; Kautsky and Kautsky, 1989;). As a result, fluctuation in the distribution and abundance of bladder wrack are likely to influence the state of biodiversity of coastal Baltic ecosystem including all trophic levels (Haahtela, 1984).

Bladder wrack, *Fucus vesiculosus* L., is widely distributed in the northern hemisphere (Lüning, 1990). In the Baltic Sea *F. vesiculosus* is wide spread on hard substratum and often dominates shallow macroalgal communities. As the only fucoid species, it penetrates all the way into the Gulf of Bothnia in the north and to the Gulf of Finland in the east where it lives close to its tolerance limit of salinity. This limit lies around salinities of 4 psu (Rosemarin and Notini, 1996), with occasional reports of isolated and sparse populations at salinities down to 2 psu (Waern, 1952). Though *F. vesiculosus'* habitat requirements with respect to salinity are fulfilled almost everywhere in the Baltic Sea, the alga also requires firm substrate and low-moderate exposure to ice and waves in order to form stable and healthy communities. The distribution of species has a strong biological control through competition for space with other perennial macroalgae in the southwestern parts of the Baltic Sea where salinity is higher while this control disappears in the areas where salinity drops and other perennial macroalgae are no more able to compete for the substrate. Thus, in the inner Baltic Sea, the distribution of the species is mainly controlled by the environmental variables such as light availability (Figure 3.2.2).

Several studies indicate that *F. vesiculosus* in the Baltic Sea is threatened by pollution both locally close to point sources and on a larger scale due to a general eutrophication of the Baltic Sea (e.g. Kautsky et al., 1992, Schramm, 1996). Decreases in distribution and disappearances of *F. vesiculosus* have been reported from locally polluted areas such as the inner Stockholm Archipelago, the Tallinn Bay, the Gulf of Gdansk, the Helsinki Archipelago and the Gulf of Riga. Decreases have also been reported from areas with little local pollution, e.g. the Lagskär skerries, the Tvärminne area and the Öregrund Archipelago and it has been suggested that large-scale hydrographical changes may have contributed to the negative development in *Fucus* communities (Torn et al 2006).

Zostera marina (eelgrass)

Seagrasses are marine angiosperms providing important ecological components of coastal ecosystems worldwide. Out of 66 known seagrass species only two inhabit the Baltic Sea and only one, eelgrass *Zostera marina* L. is found in the most of the Baltic Sea. This species provides a structure for the benthic environment and associated communities on soft, sandy bottoms.

Zostera marina inhabits relatively sheltered sandy bottoms at depths where wave action can not disturb the sediment. Wave and ice prevents this species to inhabit the shallowest parts of the coastal slope while the light availability limits its depth distribution.

The depth distribution of eelgrass is not to be affected by the salinity gradient in the Baltic Sea (Baden & Boström 2001). This is not surprising because eelgrass can tolerate a very broad range in salinity (5-35 psu, den Hartog 1970). A study on eelgrass depth limits in the Kattegat/Belt region also shows no correlation between depth limits and salinity (Greve & Krause-Jensen 2003). At the same time it takes longer to re-establish deep eelgrass communities at the lower salinity limit in the inner Baltic where eelgrass mainly grows vegetatively (Reusch et al. 1999) than at the entrance of the Baltic where seeds play an important role in its dispersal (Nielsen & Olesen 1994).

In the Baltic there have been considerable changes in the distribution characteristics of eelgrass in the past. The wasting diseases almost whiped out the species from southern Baltic Sea in the 1930s. In most of the areas (Danish and German coast) the former distribution range has not been recovered or the conditions have worsened during recent decades. Polish, Lithuanian and Latvian coasts lack the species nowadays almost completely. The area and abundance of this species in other areas have fluctuated considerably while lack of comprehensive monitoring data makes the assessment of the current conservation status of this species difficult. The main threats to the eelgrass communities nowadays are eutrophication and mechanical disturbance of the seafloor both affecting significantly the light climate on the seafloor and quality of habitat.

Furcellaria lumbricalis

In the Baltic Sea at least two ecologically distinguished forms of the red algal species *Furcellaria lumbricalis* (Huds.) Lamour are found. The attached form of this species is very common on the hard bottoms of the lower part of phytobenthic zone of the Baltic Sea (Nielsen et al., 1995). Loose-lying *F. lumbricalis* on the contrary is very unique. Currently only three localities have been described having large communities of this form in the Baltic Sea. One of these (Puck Bay) has already lost the population due to eutrophication and pollution problems (Kruk-Dowgiallo & Ciszewski, 1994). Austin (1959) has described a similar agglomeration of loose *Furcellaria* in the central Kattegat area. The sea area of the West Estonian Archipelago hosts the largest known community of this kind, where a mixed community of loose-lying *Furcellaria lumbricalis* and *Coccotylus truncatus* covers up to 120 km^2 of sea bottom with more than 140 000 tonnes of wet biomass in Kassari Bay. (Martin et al 2006ab)

Due to its physiology this species can tolerate low light intensities and therefore penetrates to the depths where majority of other species are not able to survive. According to recent monitoring data this species penetrates to the depths of 6 to 10 meters in the most of the Baltic Sea area with the absolute maximum depth values of 16.5 m in the entrance area of the Baltic Sea (Figure 3.2.3). This species usually forms the belt deeper than bladder wrack while the biomass of the communities are much lower, usually not exceeding 300 – 400 g/m^2 dry weight. Adaptation to larger depths enables this species to occupy also the extremely exposed coastal areas as Latvian, Lithuania and Polish coasts.

Charales (stoneworts)

In the Baltic Sea charophytes dominate soft bottom areas within the photic zone together with phanerogams and are common in shallow sheltered bays (Mathieson & Nienhuis, 1991). Charophytes are found all over the Baltic Sea area. Recently (since 1981) 12 species belonging to the genus *Chara* are recognized in the Baltic Sea. A number of freshwater charophytes can occasionally be found at river estuaries and adjacent sea areas but usually these species do not spread further to sea. The highest number of charophytes could be found in easternmost and northernmost areas of the Baltic Sea (Figure 3.2.4.). Most common species in the Baltic Sea is *Chara aspera* Willd. *Chara baltica* Bruzelius is also distributed all over the Baltic Sea area and could be found on both sheltered and moderately exposed coastline. One of the rare species, *Chara connivens* Salzm. Ex A. Braun, is considered to have been brought to the Baltic Sea by ballast sand and boulders in sailing ship era, has a very narrow distribution area in the Baltic Sea while being very abundant in its distribution area (Figure 3.2.5).

In the Baltic Sea charophytes inhabit mostly sheltered coastal areas where their distribution pattern is primarily controlled by the salinity regime, settlement depth, sediment type and exposure (Schubert & Blindow 2003).

In recent decades, the number of species, distribution area and biomass of charophytes have significantly declined in the Baltic Sea (Schubert & Blindow 2003, Munstrehjelm 2005). Most of the records on considerable decline of charophyte populations are from coastal waters of Schleswig-Holstein, Swedish west coast and the coastal waters of Hanko peninsula in SW Finland (Shubert & Blindow 2003). The decline of charophytes is mainly caused by mechanical stress, combined with destruction of habitats and human induced pressures such as eutrophication (Yousef et al 2001, Munstrehjelm 2005).

Mytilus edulis (Blue mussel)

Blue mussels, *Mytilus edulis* L., dominate the shallow hard bottom below the vegetation belt in the Baltic Sea, with abundances up to 36 000-156 000 individuals m^{-2} (Kautsky 1982). In the northern Baltic, blue mussels are most often found in the depth range 0-25 meters (Westerbom 2006) and usually start to decline after 30 m depth. Blue mussels dominate the animal biomass on hard substrate and because of their dominance are considered to be one of keystone species in the Baltic. Quantitatively Blue mussels constitute up to 80-90% of total animal biomass in the shallow areas of the northern Baltic Sea (Kautsky et al 1990). Blue mussels are considered to be an important link between benthic and pelagic components of Baltic ecosystem, channelling the flow of energy and matter, being able to annually filtrate the amount of water corresponding to the volume of entire Baltic Sea (Kautsky 1981, Kautsky & Kautsky 2000).

Considerable fluctuations in densities and biomass of blue mussel have been recorded at different locations in the Baltic Sea (Westerbom 2006, Estonian Marine Monitoring data). These fluctuations can not be explained by variation in environmental conditions (e.g. salinity, nutrient concentrations etc.). Instead virus disease or periodical oxygen deficiency might have influence on *Mytilus* abundance on local scale, especially in areas having eutrophication problems.

3.2.2 Modelling habitat and species distribution

Maps showing the distribution of species and habitats are important instruments for an effective spatial planning and management of ecosystems. Such maps have until recently been lacking for marine environments, largely due to the difficulties to achieve biological data with a good spatial cover. Since remote sensing techniques are not applicable for benthic habitats, except for very shallow areas, the information on species and habitats is generally restricted to a few points in space, representing diving inventories, sediment samples or other types of sampling stations. In most cases, these points cover only a tiny fraction of an area of interest (Figure 3.2.6).

Spatial modelling is a useful tool for transferring such point information to underwater maps, showing the distribution of species and habitats (Figure 3.2.6). In short, spatial modelling works by finding a statistical relationship between the presence of a certain species or habitat and a number of environmental conditions, such as depth, wave exposure, bottom substratum etc. The presence of the focal species or habitat in each part of a map can then be predicted using data layers describing environmental conditions. Maps produced by spatial modelling can thus visualise the distribution of species or habitats in an entire area of interest and provide a quantitative measure of how much of the area that is covered by a certain species or habitat. They can also be used as an input in spatial planning with GIS tools including establishing of conservation values (Isæus et al. 2007) (Figure 3.2.7) or spatial planning of MPAs using for example the software MARXAN (see chapter 7)(Ball and Possingham 2000).

Along with the many advantages of maps produced by spatial modelling, it is important to acknowledge that for the production of reliable maps it is crucial to have high-quality background data. The quality and resolution of predicted maps can never get better than the underlying data layers. The first step for predictive spatial modelling must therefore always be to assemble high-quality maps of the environmental factors that are expected to explain the distribution of the species or habitats of interest.

There are a number of successful examples where maps of benthic seaweeds, plants, sessile animals, fish and habitats have been produced using these techniques. A table with references to a number of habitat or species distribution models is given in Annex III of this report. The examples include mostly detailed models at a local scale bur also some overview modelling examples including the whole Baltic Sea. Many of the studies were performed within the BALANCE project and are found in the BALANCE interim reports 11 (Bergström et al. 2007), 21 (Dahl et al. 2007), 23 (Müller-Karulis et al. 2007), 27 (Dinesen et al. 2008). These modelling examples are scattered from the Southern Quark to Skagerrak. There are also examples from the Gulf of Bothnia and the Bothnian Sea of modelled benthic species and habitats on Swedish offshore banks (Naturvårdsverket 2008). In Latvia and Lithuania habitat modelling has been combined with EUNIS classification in order to produce national benthic maps also including mussel dominated habitats. In Estonia spatial modelling is used as standard technique for mapping the distribution of key species and habitats in the inventories of marine Natura 2000 sites (Martin et al 2008). See also Box 3.2.1 for an example of modelling changes in *Fucus vesiculosus* distribution.

There are also several ongoing activities that will be finished during 2008 or early in 2009. In Sweden, detailed maps of species' distributions are currently produced for three pilot areas in the Bothnian Bay, the Bothnian Sea and the Baltic proper (financed by Swedish EPA). In the same time, a first attempt is done to model the distribution of habitat forming species on the scale of the entire Baltic Sea within the project MOPODECO, a project funded by the Nordic Council of Ministers. The quality of these maps will vary spatially due to variation in the abundance and quality of input data.

Implications for the Baltic Sea Action Plan

HELCOM has acknowledged the need for mapping of important marine species and habitats in the Baltic Sea. In the Baltic Sea Action Plan, it is stated that the goal is to, by 2013, identify and map the distribution of a number of habitat-forming species, including bladder wrack (*Fucus vesiculosus*), eelgrass (*Zostera marina*) and blue mussel (*Mytilus edulis*). This work has already been initiated and the experiences this far suggest that spatial modelling is a promising tool.

In order to achieve the goal of the BSAP by 2013, it may in some cases be necessary to produce a first generation of somewhat coarser maps if the input maps are not of sufficient quality or detail. During the production of these maps the shortcomings of the input data should be analysed and efforts for improving the data sets should be suggested. A second generation of maps with higher quality and detail may be produced when the input data sets have been improved.

3.2.3 Conclusions

The conservation status of several habitat forming species (e.g. bladder wrack, stoneworts and eelgrass) in the Baltic Sea as a whole is unfavourable. Declines in species abundances as well as distribution area have been recorded recently. Most problematic sea areas seem to be the southernmost areas of the Baltic Sea. At the same time, coastal areas of northern Baltic Proper show recent improvements and here the natural distribution of several keystone species is almost achieved. For other important species (e.g. *Furcellaria lumbricalis*, blue mussel) the status is difficult to determine due to lack of recent and systematic monitoring data.

The use of spatial modelling in marine applications has increased rapidly over the last years and is now a key tool in mapping the marine environment. Modelling will be used not only to map the current state, but also the changes in distributions of species and habitats in response to environmental changes. To be able to use the full potential of the tool much effort must also be put into collating existing data and collecting new data on species and environmental parameters covering the Baltic Sea.

3.2.4 Recommendations

In order to achieve the targets set by BSAP and reach the favourable conservation status of all habitat forming species it is crucial to establish effective monitoring systems as well as system of regular assessment of the status.

It is recommended that effort is put into production of high-quality maps of structuring environmental factors. This includes environmental factors that are important at the local scale (bathymetry, wave exposure, surface sediment etc), but also additional factors that are known to affect species distributions on the regional scale, for instance salinity and climatic factors.

Secondly, there is a need for representative species field data, covering all existing environments. A lot of data can likely be assembled from existing data collected by national inventory and monitoring programs. If the data abundance is low in certain habitat types or regions, there will also be a need for more data collection based on identified data deficiencies.

3.2 FIGURES

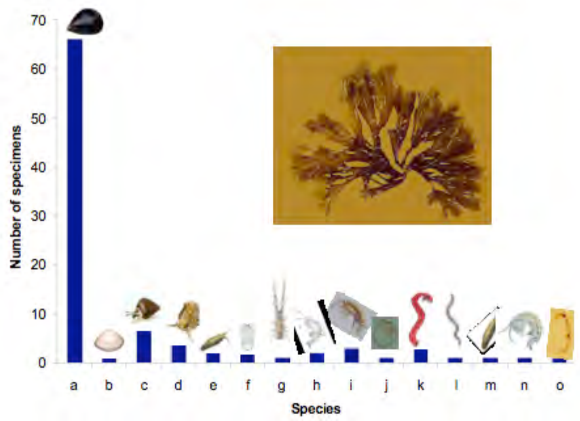


Figure 3.2.1. Number of associated species living on one *F. vesiculosus* plant (collected from west coast of Saaremaa island from depth of 5.8 m in 2007). Figure prepared by Liis Rostin. *a - Mytilus trossulus, b - Macoma baltica, c - Hydrobia ulvae, d - Theodoxus fluvitailis, e - Idotea baltica, f - Jaera albifrons, g - Corophium volutator, h - Gammarus juv., i - Gammarus salinus, j - Cerastoderma galucum, k – Chironomidae, l - Hediste diversicolor, m - Idotea baltica, n - Gammarus oceanicus, o – Oligochaeta.*

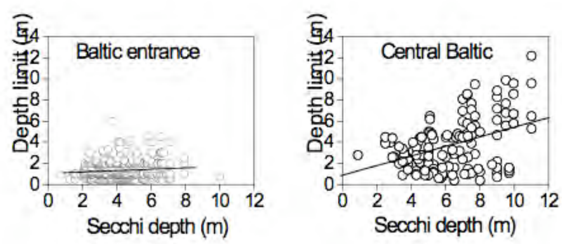


Figure 3.2.2. Relation between depth distribution of *Fucus vesiculosus* and water transparency in the Baltic entrance area (including data from Kattegat, the Danish Belts, Øresund and the Baltic between Zealand and Scania) and Central Baltic (including data from Gulf of Kiel, Hanö Bay, the Arkona Sea, the Baltic Proper, the Gulf of Riga and the Gulf of Finland). Modified from Torn et al 2006.

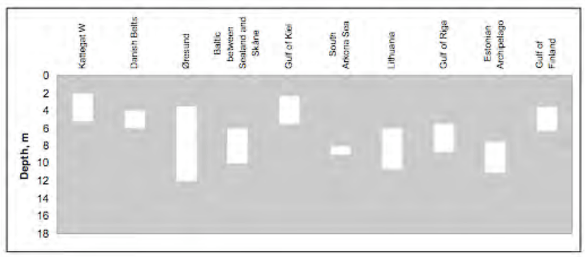


Figure 3.2.3. Maximum depth penetration of *Furcellaria lumbricalis* in different sea areas of the Baltic Sea. Boxes delimit the 25 and 75% percentiles and whiskers minimum and maximum values. Data from 1989 to 2007.

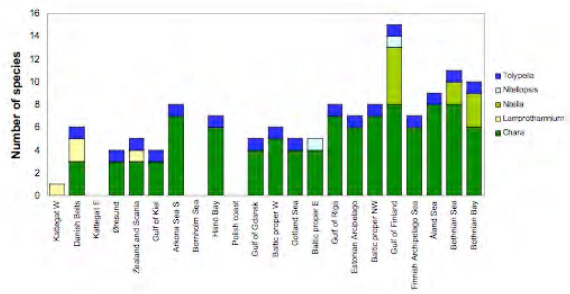


Figure 3.2.4. Number of Charophyte species in different areas of the Baltic Sea. (Data from Schubert & Blindow 2003, Torn 2008. Divison of the Baltic Sea after Nielsen et al 1995).

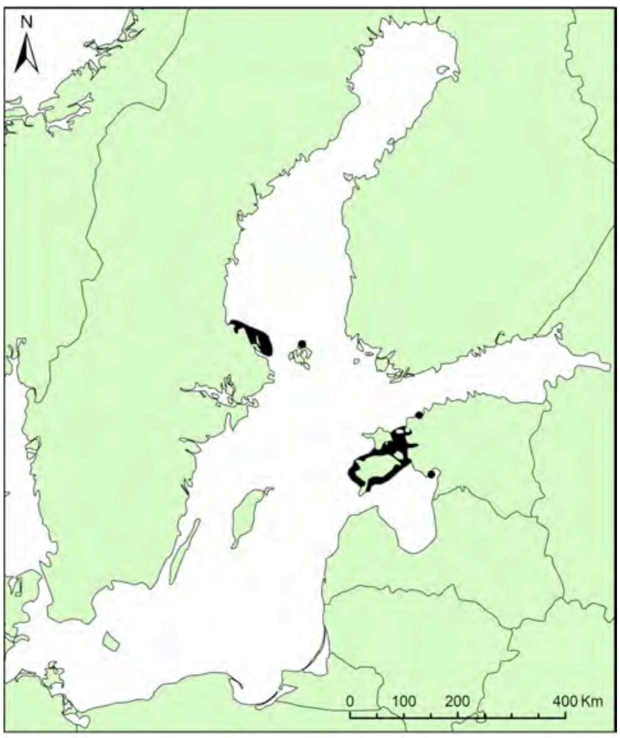


Figure 3.2.5. Present distribution of invasive *Chara connivens* in the Baltic Sea (From Torn 2008).

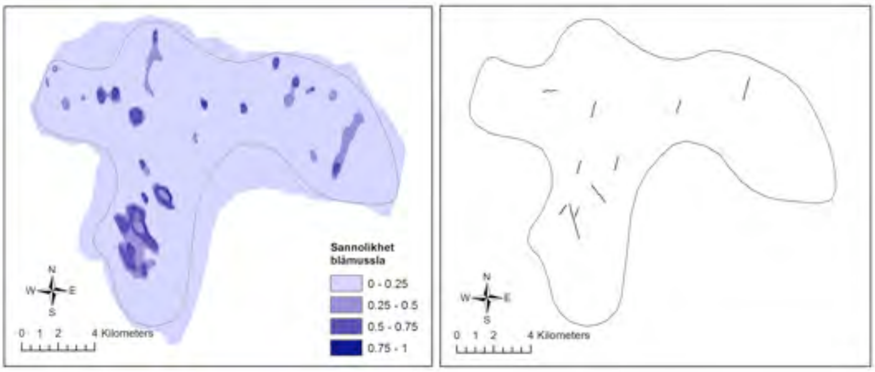


Figure 3.2.6. The modelled distribution of blue mussel on the Vänta litet offshore bank, Bothnian Sea. The map shows the predicted likelihood (between 0 and 1) for the occurrence of blue mussel. The right panel shows the video transects that were used as input for the spatial modelling, in themselves conveying much less information of the spatial distribution of the species. The map is produced by AquaBiota Water Research for a report on species distribution on Baltic off-shore banks (Naturvårdsverket 2008). Reprinted with permission from Swedish EPA.

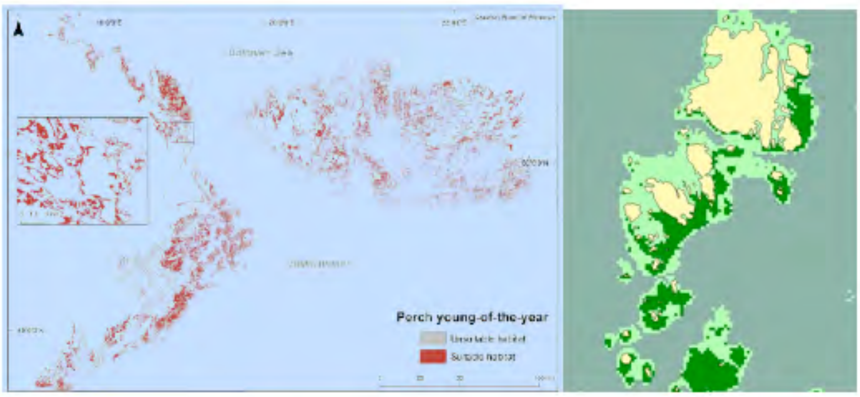


Figure 3.2.7. Left panel shows prediction of perch young-of-the year habitats in the southern quark area. By U. Bergström, A. Sandström and G. Sundblad, in the Balance interim report 27. The right panel shows classes of marine conservation values at Svenska Högarna, Stockholm archipelago (Isaeus et al. 2007). The map is constructed from overlay analyses of eight layers of species and habitat distributions. Light green shows high and dark green very high conservation values respectively. Permission for reprinting the images is given by Swedish Board of Fisheries and Stockholm administrative county board.

3.2 BOXES

Box 3.2.1 Changes of *Fucus vesiculosus* distribution – a modelling example

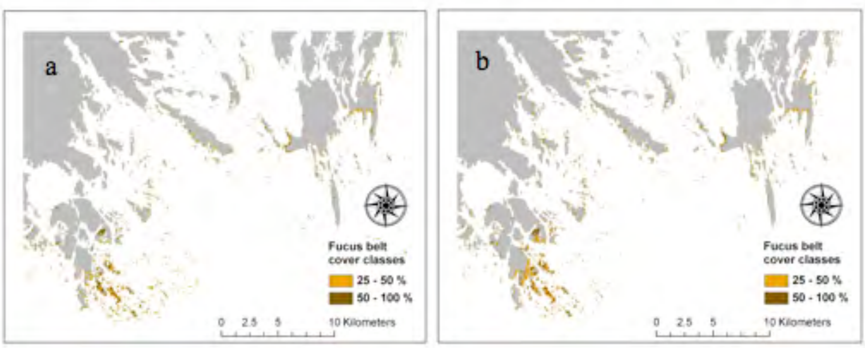
After a period of poor water transparency in the Stockholm archipelago the Secchi-depth has improved during the last decade. Although the variation of water transparency is high the trend at the phytobenthic monitoring stations in the Askö area shows an increase of about a meter in Secchi-depth values collected during the yearly inventories in August. The water transparency affects the light condition by the seafloor and is thereby a determinant setting the maximum depth distribution of macro algae and other plants. As a part of the HELCOM BIO project a model was constructed to calculate a quantitative measure on the changes in bladder wrack *Fucus vesiculosus* distribution in a habitat perspective. The model was constructed in cooperation with Stockholm University.

By using statistical modelling (GRASP, Lehmann et al. 2002) predictions of *F. vesiculosus* distribution was produced for 1993 and 2006 in the Askö area, Stockholm archipelago. The modelling was based on data from 30 stations in the Swedish phytobenthic monitoring program, wave exposure at the seafloor (Isæus 2004, Bekkby et al. in press), light availability at seafloor (Bekkby et al in prep), reclassified marine geology (Cato et al. 2003), and slope and aspect derived from nautical charts via a TIN-DEM.

The resulting maps showing the distribution of *F. vesiculosus* belts in the two abundance classes 25-50% cover and 50-100% cover look quite similar at a first glance. However, by using a summarising tool in GIS the area of each class may be calculated showing that both classes have increased their distribution area during the period, by 17% and 2% respectively. An integrated analysis of *Fucus* belts with 25% cover or higher shows an 12% increased belt area (see table). The depth distribution of *F. vesiculosus* has decreased during the period 1943-1984, and decreased Secchi-depth was given as the most likely explanation to this (Kautsky et al. 1986). In correspondence to that the increase of *F. vesiculosus* depth penetration and area cover shown in this study probably is an effect of improved water transparency in Askö archipelago due to improved sewage water treatment at the Swedish coast. Unfortunately this trend of improved water quality is not found in many of the Baltic coastal areas.

Table. Distributions of modelled *Fucus vesiculosus* distribution in the Askö area, Stockholm archipelago 1993 and 2006. During this period has the estimated area of *F. vesiculosus* belts with more than 25% cover increased by 12%.

1993		2006		Difference	Increase
25-50	11 491 875	25-50	13 454 375	1 962 500	17%
50-100	5 306 875	50-100	5 419 375	112 500	2%
25-100	16 798 750	25-100	18 873 750	2 075 000	12%



Distribution of *F. vesiculosus* belt classes modelled from a) 1993 monitoring field data, and b) from 2006 field data.

3.3 Zooplankton communities

Zooplankton forms an important link in the ecosystem by transferring energy from primary producers to consumers of human interest, namely the fish. Zooplankton are suitable as indicators of pelagic ecosystem conditions since, in addition to their key role in energy transfer, they are short-lived (maximum 1 year) and directly affected by changes in hydrography. Hence, changes in zooplankton assemblages are reflected directly and rapidly in fish growth and stock conditions. Factors that influence zooplankton may be bottom-up processes, where abiotic factors like salinity or temperature regulates the food web from lower levels to higher. On the other hand, zooplankton may also be affected by top-down processes, where predators such as sprat or herring control their abundance. These processes at higher levels of the Baltic pelagic food web have been demonstrated recently, also highlighting the top-down control (e.g. Flinkman et al, 1998, Möllmann & Köster, 1999, Möllmann et al., 2005, Casini et al., 2006).

There are no targets of the Baltic Sea Action Plan (BSAP) that directly address zooplankton. However, several targets are linked to the state of the zooplankton community, primarily the overaching goal *"By 2021 all elements of the marine food webs, to the extent that they are known, occur at natural and robust abundance and diversity"*. In addition, all fish are planktivorous as larvae, and some species remain as such all their lives. This is the case for Baltic herring and sprat, both of which are essential food sources for salmon and gadoid fish in the Baltic. The BSAP targets 50-80% of potential production of wild salmon in river populations by 2015. Further, viable Baltic cod populations in their natural distribution area should be reached by the same year. This will be difficult to achieve, if the food web loses high energy marine copepods as discussed in this section.

3.3.1 Status and trends

The Baltic Sea zooplankton community is a mixture of neritic and euryhaline marine species, and purely fresh water species. Zooplankton are often classified by size as nanoplankton 2-20 µm (flagellates), mikroplankton 20-200 µm (ciliates, small rotifers), mesoplankton 0.2-2 mm (big rotifers, cladocera, copepods, different meroplanktic larvae), or makroplankton >2 mm (mysids, juvenile fish). Almost 800 ciliate species are found in open and coastal waters of the Baltic Sea and the open Baltic also harbours about 200 meso- and macrozooplankton species (Telesh et al. 2008). Mesozooplankton is the dominating group in the Baltic Sea in terms of biomass.

Crustacean mesozooplankton, i.e. copepods and cladocerans, are of particular interest here, as they are the key players in the pelagic food web, and form the staple diet of planktivorous fish. Altogether, there are less than 15 copepod and 20 cladoceran genus present in the Baltic Sea. As these species have different adaptation capabilities in relation to salinity and temperature, their distribution differ considerably. A general trend of decreasing marine species, and increasing fresh water species towards north and east can be observed. A comprehensive description of the Baltic Sea zooplankton can be obtained from Telesh et al. (2008).

Of copepods, truly marine species such as the large size Calanus family are missing altogether in the Baltic Sea while in the North Sea, Northeastern Atlantic and Polar Seas they are key species as food for planktiovorous fish. Marine copepods found in the Baltic are neritic, coastal and estuarine small size species, which all share a common feature, the ability to adapt to low salinity. The most pronounced marine species are *Pseudocalanus acuspes* and *P. elongatus*, which thrive in deep, saline water below the halocline. Other neritic species are *Centropages hamatus* and *Temora longicornis*, which are less dependent on sub-halocline habitat than *Pseudocalanus* spp. *Acartia* and *Eurytemora* families are coastal and estuarine marine species, but have even better adaptation capabilities to fresh water environment. *Limnocalanus macrurus* is a stenothermic fresh water species occurring in low salinity deep water in Gulf of Finland, Åland Sea and Bay of Bothnia system.

Most cladoceran species are of fresh water origin, except *Evadne*, *Podon* and *Pleopis* families, which are found in coastal ecosystems of adjacent marine environments. A recent invader, *Cercopagis pengoi* from the Pontocaspian region is a brackish water species.

Copepods, which are important food sources for economically important fish species, are proposed as useful indicators for monitoring the health of the Baltic Sea pelagic food web. Species that have been given particular attention in this assessment are: 1) *Pseudocalanus* spp., which is a species very dependent of salinity changes and deep water oxygen content, while being a significantly selected, high energy food item for the herring, 2) *Temora longicornis* which is less dependent on abiotic change, is still positively selected by herring, but that has a lower energy content than *Pseudocalanus* spp., and 3) *Acartia* spp., a species of low energy content, not preferred by herring, and in addition perhaps most insensitive to abiotic changes (Flinkman et al. 1998). The assessment of these species is restricted to the Northern Baltic Proper, Gulf of Finland, and Southern Baltic Sea.

Northern Baltic Proper and Gulf of Finland

The available monitoring data from the last 28 years shows no significant trend in overall abundance or biomass development of zooplankton in the Northern Baltic Proper. Of the main zooplankton groups, copepods showed no distinct trend, while cladocerans displayed a downward trend. However, there are distinct changes in abundance among copepod species. The copepod genus *Pseudocalanus* spp. has significantly declined during the observation period ($p<0.001$), whereas other copepod species such as *Temora longicornis*, *Eurytemora* spp, *Centropages hamatus* and *Limnocalanus macrurus* have increased (Figure 3.3.1). The *Acartia* spp. group showed no clear trend over the observation period (Figure 3.3.1).

Zooplankton communities in the Gulf of Finland show similar trends to those of the Baltic Proper, although not as clear. There is no significant trend in overall zooplankton biomass but at the species level, the copepod *Pseudocalanus* spp. displays a decreasing trend ($p<0.05$), while *T. longicornis* and *Acartia* spp. are increasing (Figure 3.3.2).

Southern Baltic Sea

The changes in abundances of calanoid copepods in the central and southern Baltic Sea are not as clear as in Gulf of Finland and northern Baltic Proper. In these areas, data is available from 1995 and between the years 2000-2005. The annual maximum abundance of all species was relatively constant during this period. A peak standing stock of about 30 000 individuals per m^3 was achieved annually, possibly indicating maximum carrying capacity of the region. However, there was a clear change in relative abundances of different species during the observation period. In comparison to the *Acartia* spp. and *T. longicornis*, the abundance of *Pseudocalanus* spp. was up to one order of magnitude less in 1995 and 2000-2005. This is in contrast to the situation in the 1980s, when *Pseudocalanus* spp. was the dominant calanoid copepod in Baltic Sea proper (Postel et al., 1996).

The same general trend with decreasing abundance of *Pseudocalanus* spp. counterbalanced by *Acartia* spp. and *Temora longicornis* is also observed in data from the entrance of Gdansk Bay (Witek, 1995) and Bornholm Basin (Figure 3.3.3a-c).

3.3.2 Factors influencing and explaining the status of Baltic copepeds

Changes in the abundance of copepod species during the period of observation can be attributed to a complex interaction between salinity, temperature, predation, and possibly also eutrophication.

Pseudocalanus and *Centropages* are the two genera that are most sensitive to decreasing salinity among the studied copepods. In the Bornholm Basin the decline of *Pseudocalanus* lasted until the mid 1990s (Figure 3.3.3a). Saline inflows in 1993 and 2003 increased the salinity and oxygen content of the deep water (Figure 3.3.4a,b; Feistel et al. 2004) and caused a subsequent reverse trend in *Pseudocalanus* spp. abundance in the central Bornholm Basin. However, *Pseudocalanus* spp. never reached its peak concentration of 1984. This could be a result of the higher frequency of hypoxic and anaerobic conditions in the late 1990s and in 2004, which has reduced the volume of preferred habitat layer of *Pseudocalanus* spp. between the top of the anoxic bottom layer and under 8 psu salinity layer (Postel, 2005). There seems to be a dependency between the habitat layer thickness and the *Pseudocalanus* abundance.

While the decline in *Pseudocalanus* abundance can be at least be partly linked to the decreasing salinity during the study period, the *Centropages* are also sensitive to decreasing salinity and still showed an increase during the period. This can possibly be explained by food preference of the main copepod predators. *Pseudocalanus* is perhaps the most preferred prey of Baltic planktivorous fish (e.g. Kornilovs et al. 1992, Flinkman et al. 1998, Möllmann et al. 2003, Casini et al. 2006). Thus, the decrease in *Pseudocalanus* abundance may periodically be enhanced by top down control from the increased sprat stock during the observation period. *Centropages* on the other hand is not selected, and in fact has a very effective escape reaction (Viitasalo et al. 1998).

Temora longicornis which increased during the period are also strongly selected by clupeids (cf. references given above). However, *T. longicornis* is not as sensitive to salinity changes as *Pseudocalanus* and the species is furthermore a thermophile and may possibly have been stimulated by the increasing summer temperature during the period (Figure 3.3.4c) (Hernroth and Ackefors, 1979).

The reverse increasing tendency in biomass concentrations of *T. longicornis* and partly in *Acartia* spp. may also have other complex reasons. It could be the result of a potential carrying capacity for calanoids. Also, a decreasing eutrophication may affect the smallest calanoids in the Baltic Sea, the *Acartia* spp. (Figure 3.3.3c), as the biomass concentrations of the *Acartia* spp. follow decadal course of the winter concentration of nitrate in the upper 10 m of the central Bornholm Basin (Figure 3.3.4d).

During the observation period the Baltic Proper, with the exception of Åland Sea, has suffered from severe oxygen starvation periods in deep basins. This has significantly decreased the available water volume for species that thrive in deep, saline water under the halocline. As discussed above, this affects *Pseudocalanus* spp., perhaps the most important zooplanktonic prey item for Baltic herring. Hence it may well be that human-induced eutrophication, and subsequent oxygen deficiency has a role in regulating Baltic Proper zooplankton as well.

3.3.3 Conclusions

During the past 20-30 years the copepod communities in the Baltic Sea have undergone considerable changes. The causes behind the changes, as well as their eventual effects, are sometimes difficult to define and distinguish. Climate variability with subsequent influence on salinity and temperature can likely explain some of the observed changes, while human pressures such as eutrophication also may have contributed. The observed changes in zooplankton communities have had cascading trophic effects which can be observed as reduced weight at age, general condition and reproduction of Baltic herring and sprat. Further, these changes combined with subsequent effects to planktivorous fish stocks have affected growth, condition and reproduction of Baltic salmonids (e.g. Ikonen 2006), emphasizing the socio-economic impact of changes in Baltic zooplankton communities.

3.3.4 Recommendations

Zooplankton are currently not a core variable in the HELCOM COMBINE monitoring programme. Based on the important role of zooplankton in the Baltic Sea food web and its usefulness as an indicator for pelagic ecosystem conditions it is recommended that zooplankton is included as a core variable in this monitoring programme.

3.3 FIGURES

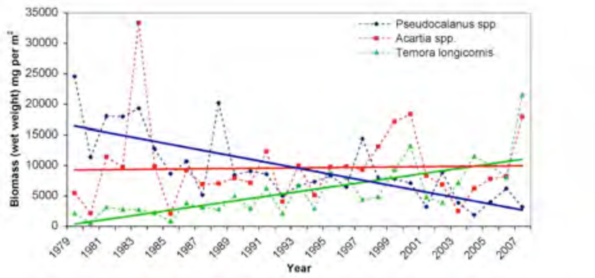


Figure 3.3.1. Northern Baltic Proper. Biomass of copepods *Pseudocalanus* spp., *Temora longicornis* and *Acartia* spp.

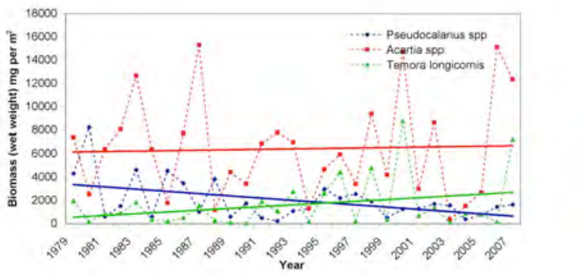


Figure 3.3.2. Gulf of Finland. Biomass of copepods *Pseudocalanus* spp., *Temora longicornis* and *Acartia* spp.

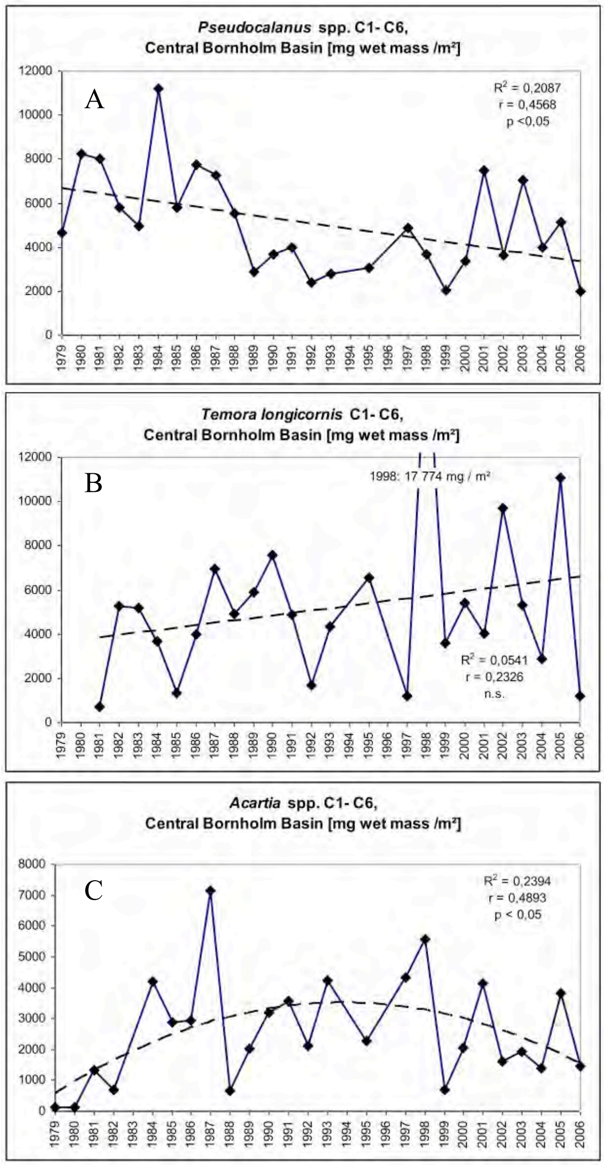


Figure 3.3.3. Wet mass concentration of *Pseudocalanus* spp. (a), *Temora longicornis* (b), and *Acartia* spp. (c) in the central Bornholm Basin during summer between 1976 and 2007 calculated from data (HELCOM and IOW sources) and by use of biomass factors according to Hernroth et al., 1985), after Postel, in prep.

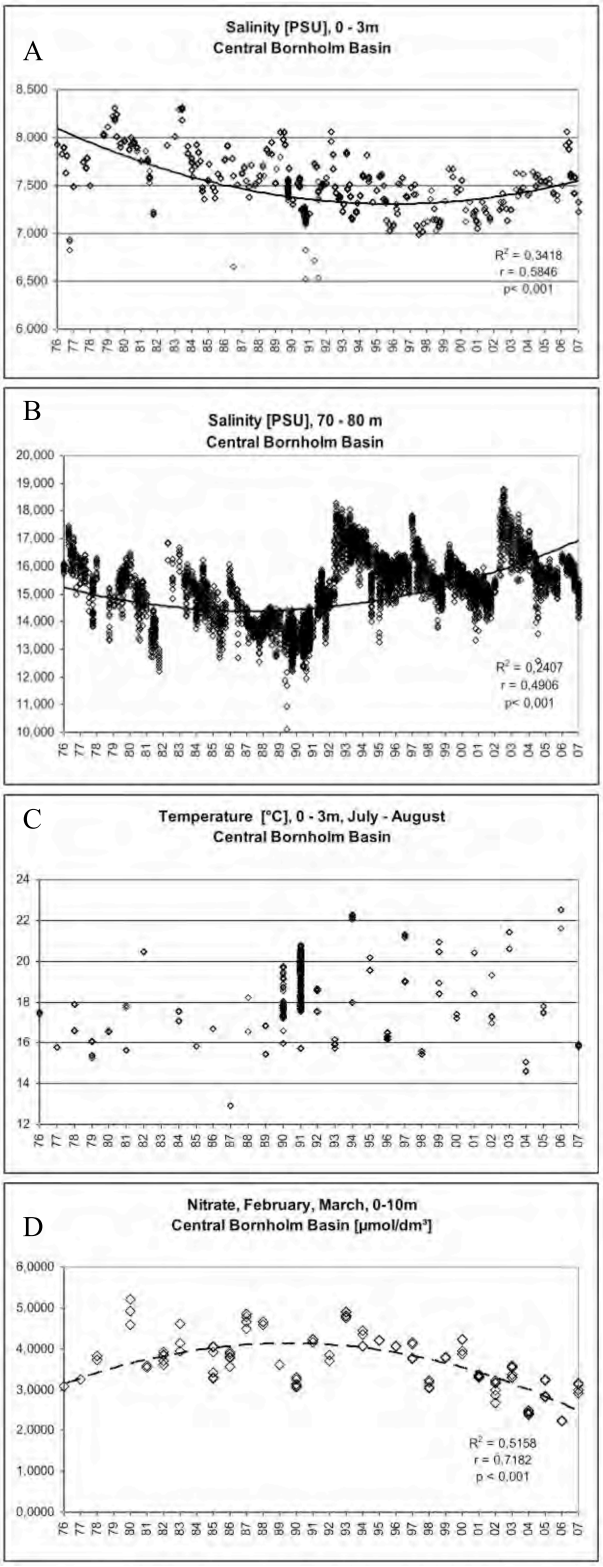


Figure 3.3.4. Salinity of the upper 3 m (a), salinity of the layer between 70 and 80 m (b), temperature of the upper 3 m (c), and winter nitrate concentration in the upper 10 m (d) in the central Bornholm Basin between 1976 and 2007 (from IOW data base) after Postel, in prep.

3.4 Benthic invertebrate communities

Soft-sediment macrofaunal communities are central elements of Baltic Sea ecosystems and provide important ecosystem functions and services. These functions include, for example, the provision of food for higher trophic levels and through the processing, reworking and irrigation of the sediments, benthic macrofauna enhance oxygen penetration and biogeochemical degradation of organic matter in the sediments. Most macrobenthic animals are relatively long-lived (several years) and thus integrate changes and fluctuations in the environment over a longer period of time. Hence variations in species composition, abundance and biomass can be used to assess environmental conditions and disturbance events.

In the context of the Baltic Sea Action Plan, benthic invertebrate communities relate to the ecological objectives of the BSAP, which aim for *"Thriving and balanced communities of plants and animals"* and *"Viable populations of species"* in order to secure a favourable conservation status of Baltic Sea biodiversity. Specifically these objectives relate to restoring and maintaining seafloor integrity at a level that safeguard the functions of ecosystems. The relevant BSAP targets include that by 2021 (a) a 'natural' range in the distribution and abundance of habitat-forming species should be obtained, (b) degradation should be halted and recovery of marine biotopes/habitats ensured, and (c) a natural abundance and diversity of all elements of the marine food web should be secured.

3.4.1 Status and trends

The distribution and diversity of brackish water macrobenthic communities in the Baltic Sea are constrained by the distinctive salinity and oxygen gradients present (Segerstråle 1957, Rumohr et al. 1996, Laine 2003). Due to the overall low salinity, benthic communities in the Baltic Sea are substantially less diverse than in fully marine environments and comprise a mix of species of both marine, brackish water and limnic origin (Remane 1934, Bonsdorff 2006). The characteristic salinity range in most of the Baltic Sea coincides with the species diversity minimum for aquatic habitats as described by Remane (1934), i.e. where the distributions of marine and limnic species meet.

The latitudinal distribution of marine macrozoobenthos in the Baltic Sea is limited by the gradient of decreasing salinity towards the north. The decreasing salinity reduces macrozoobenthic diversity, affecting both the structure and function of benthic communities (Elmgren, 1989, Ruhmohr et al., 1996, Bonsdorff & Pearson, 1999). In addition, the distribution of benthic communities is driven by strong vertical gradients. Generally, the more species-rich and abundant communities in shallow-water habitats (with higher habitat diversity) differ from the deep-water communities, which are dominated by only a few species (Andersin et al., 1978). The Baltic Proper has a more or less permanent halocline at 60-80 m, whereas in the Gulf of Bothnia stratification is weak or absent. The halocline in deeper waters or seasonal pycnoclines in coastal waters restrict vertical water exchange, which may result in oxygen deficiency and a severe reduction or complete elimination of macrozoobenthic communities. Oxygen deficiency is without question the most significant threat to the biodiversity of Baltic Sea benthos.

In this assessment we provide a brief overview of the status of structural and functional biodiversity of benthic macrofaunal communities in the major basins of the open-sea areas of the Baltic Sea. While biodiversity-environment relationships are increasingly well understood in the context of species richness and composition, functional diversity has received much less attention. The implications of changes in functional diversity and how this might translate into information of ecosystem functioning are important, and a challenge for studies of biodiversity. These aspects are perhaps particularly critical in the Baltic Sea, where functional redundancy is predicted to be low due to the low overall species and functional diversity.

Patterns in structural biodiversity

As measures of structural diversity in macrobenthic communities for the assessment period (2000-2006), different diversity indices were calculated. A simple measure of average species diversity (gamma-diversity) was used to define reference conditions and current status for the major sub-basins in the Baltic Sea (see HELCOM EUTRO 2009 for a detailed description). The reference values calculated for this measure are based on data obtained from multiple monitoring stations per sea area over the period 1965-2006, collected by the Finnish Institute of Marine Research since 1965. Additional data from Sweden was received for the Bornholm and Arkona basins. In assessments of diversity it is important to recognise that the Baltic Sea ecosystem is a young and continuously evolving system, still undergoing post-glacial succession (Bonsdorff 2006). Hence decadal time-scale fluctuations in salinity regimes and consequent changes in benthic communities continuously shift the baseline for assessing reference conditions, which needs to be considered. This obviously creates difficulties for setting absolute and fixed reference communities for the benthic fauna in the Baltic Sea. To account for the influence of successional dynamics it is important to also consider the turnover, or β-diversity of the communities. Hence, in addition to characterising the average species diversity for different open–sea areas we have also calculated β-diversity for selected stations, as well as traditional basic diversity indices, in the respective sea areas.

Benthic invertebrate communities in the majority of the Baltic Sea open-sea basins are dominated by only a few species. These species include, for example, the polychaete *Bylgides* (*Harmothoe*) sarsi, the isopod *Saduria entomon*, the amphipods *Monoporeia affinis* and *Pontoporeia femorata* and the bivalve *Macoma balthica*. A markedly different species composition is found in the SW Baltic, in the Bornholm Basin and the Arkona Basin, which are characterised by more typical marine species. These communities at least historically have typically been dominated by numerous polychaete species and larger deep-dwelling bivalves. Important phyla like echinoderms are constrained to the western reaches of the Baltic Proper and the Danish Straits.

As illustrated by the average number of species/taxa of benthic invertebrates per sea area, reference conditions contrast markedly between sub-basins due to the gradient in salinity, which constrains species distributions (Figure 3.4.1). In this broad-scale assessment, a total of eight basins were evaluated and reference conditions, i.e. average number of species that should be found, vary between 18.3 in the Arkona Basin and 2.0 in the Bothnian Bay. For the years 2000-2006 benthic invertebrate status varies considerably between sub-basins and is related to the widespread occurrence of hypoxia and anoxia in the Baltic Proper and the Gulf of Finland (Figure 3.4.1). None of the sub-basins can be regarded as pristine, even though the Gulf of Bothnia and the Arkona Basin are in a reasonable condition (as defined by the good-moderate border set by acceptable deviation; see HELCOM Eutro 2009). The entire Baltic Proper, from the Bornholm Basin to the Northern Baltic Proper and the Gulf of Finland is in a severely disturbed state (Figure 3.4.1).

Some univariate measures of biodiversity were calculated for selected, representative stations in each sea area, which highlight the nature of the overall diversity gradient in the Baltic Sea (Table 3.4.1). The total number of species recorded for the assessment period 2000-2006, ranges from 27 at BY2 in the Arkona Basin to only 3 at BO3 in the Bothnian Bay, while average species diversity ranges from 13.7 to 1.4. Correspondingly, the Shannon-Wiener diversity index ranges from 2.4 to 0.02 (Table 3.4.1). In the low diversity Baltic Sea these traditional measures, like Shannon-Wiener are not that informative. Several stations, in particular BY5 and IBSV9, demonstrate the degraded state of macrobenthic communities over the assessment period. Interestingly, Cody's measure of species turnover (βc; beta diversity) provides useful insights into the transient and dynamic nature the benthic communities in the southern Baltic Sea (Table 3.4.1). At BY2 Cody's measure reached 4.4 (which translates into an average actual species turnover of 8.8 between the years 2000-2006). In contrast species turnover in the Bothnian Bay (station BO3) gave an index value of 0.5. This obviously reflects the large differences in available species pools as well as the overall difference in biodiversity along the gradient. In addition, the dynamic nature of the southern Baltic is intimately linked to the periodic salt-water inflows.

Long-term trends in biodiversity

Long-term trends in benthic community composition from the mid 1960s to 2006 for four of the selected stations are illustrated in Figure 3.4.2. The patterns in these long-term trends exemplify the "shifting baseline" of macrobenthic communities, especially in the southern Baltic (BCSIII10) and the entrance of the Gulf of Finland (LL11), where the influence of periodic salt-water inflows are tangible. These patterns are more distinct closer to the Danish Straits and the proximity to the inflows. Since the largest recorded inflow in the 1950s, salinity has decreased in the entire Baltic Proper and the dominance has changed from marine species to typical brackish-water species at BCSIII10 (Figure 3.4.2). Similarly the 'marine' elements of the community at LL11, such as the polychaete *Terebellides stroemi*, have disappeared altogether. The nature and magnitude of the salt-water inflows has a direct influence on the strength of the halocline and hence the oxygen dynamics in the Baltic. Stratification of the water-column in combination with an increased organic loading (which has been exacerbated by eutrophication), has resulted in widespread hypoxia and anoxia. This poses a severe threat to biodiversity of benthic invertebrate communities, which is illustrated in the periodically very poor and low diverse communities recorded at BCSIII10 and LL11 (Figure 3.4.2). During the mid 1990s benthic communities recovered due to the stagnation period that weakened stratification, however, with the large salt-water intrusion in 1993 the halocline strengthened and oxygen conditions deteriorated (Norkko et al. 2007, Laine et al. 2007). In contrast, changes in species composition are low at SR5 and virtually absent at BO3 in the Bothnian Sea and Bothnian Bay, respectively. This is due to overall low species diversity. Nevertheless, invasive species, such as the polychaete *Marenzelleria* spp are conspicuous elements of the system and have established viable populations in many areas of the Baltic Sea as exemplified at SR5. In the Bothnian Sea large natural variations in abundance of the dominant species, the amphipod *Monoporeia affinis*, are typical. In this area the influence of saltwater inflows is minimal and there is not a strong halocline, which would promote the formation of hypoxia. In the Bothnian Sea the *Monoporeia* populations have been declining since the mid 1990s for reasons that have not been clarified. However, recent monitoring suggests these populations may be rebounding.

When examining long-term trends from data collected between 1965-2006, it becomes immediately obvious that conditions were already disturbed in the mid 1960s. Benthic invertebrate status in the central parts of the Baltic Sea in particular, are more or less entirely controlled by the presence or absence of hypoxia/anoxia. Already in Hessle's (1924) seminal work, hypoxia/anoxia was reported in both coastal and open-sea areas. However, he also reported on the presence of species, such as the polychaete *Scoloplos armiger* at over 140 m depth in the eastern Gotland Basin, which indicates that the spatial extent of hypoxic bottom waters was limited at that time. Current evidence suggests that the spatial and temporal extent of oxygen deficiency has increased over the past decades. In the light of historical work (Hessle, 1924) it is also likely that reference conditions defined for open-sea areas in this assessment are underestimates. Generally, Baltic benthic macrofauna are characterized by small shallow-dwelling species due to low salinity and transient hypoxia; historically it was only in the southern Baltic, where more mature communities comprised of deeper-dwelling larger species, e.g. some long-lived bivalves and large polychaetes, could have developed (Tulkki 1965, Rumohr et al., 1996). However, currently macrobenthic communities are severely degraded and abundances are below a 40-year average in the entire Baltic Sea (Norkko et al., 2007).

Functional aspects of biodiversity

The broad-scale patterns and changes in structural biodiversity also translate into differences in functional biodiversity. While the actual link between changes in the functional biodiversity and ecosystem function is difficult to quantify, it is apparent that there is a strong gradient in functional biodiversity in the Baltic Sea (Bonsdorff & Pearson 1999), which affects the trophic structure and energy flow in the ecosystem.

Biological trait analysis can be useful to identify functions that are important for ecosystem function or may help interpret the effects of disturbances (e.g. Bremner et al. 2003). Traits can be exemplified by longevity or size of particular species, their developmental mechanisms and mobility, which are all species characteristics that play important roles in classifying the state of benthic communities or reflect their potential for recovery after disturbance and are therefore important in defining resilience.

The differences in benthic functional diversity between sub-basins during the assessment period are illustrated in a basic classification at some representative stations along the Baltic Sea salinity gradient (Table 3.4.2, Figure 3.4.3). Biological traits (BT) were used to describe the characteristic functions of individual benthic infaunal species. Included main BT were feeding type, feeding habit, mobility, size, adult longevity, larval development, living habit and environmental position. Existing BT at each station are expressed as a percentage of the total BT identified for each main group of traits (Table 3.4.2), and the total number of expressed biological traits in each main group during 2000-2006 is also presented for the selected stations (Figure 3.4.3). Since one species may express several traits, the amount of traits often exceeds the total number of species at a station.

The results from this analysis highlight the increase in number of expressed traits from BO3 in the north towards the southern parts of the Baltic (Figure 3.4.3). The gradient is particularly clear for traits such as adult longevity and size, which reflects the successional stages described by Rumohr et al (1996). It is not until the comparatively more marine areas of the Arkona Basin where functional diversity increases substantially. Importantly the analysis highlights the limited functional diversity of benthic communities in the Baltic main basins.

The loss of entire functional groups and traits due to widespread hypoxia has obvious implications for the functioning of Baltic Sea ecosystems. While no permanent species extinctions in the benthos have necessarily occurred in the Baltic, it is clear that abundances over great expanses have been reduced to such a level that they may be viewed as functionally extinct, i.e. without, or with severely reduced, functional importance.

3.4.2 Conclusions

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. These conditions result in strong gradients in species and functional diversity throughout the Baltic Sea.

Obviously multiple stressors affect benthic communities in the Baltic. However, eutrophication has emerged as the major culprit, with symptoms of disturbance apparent at all trophic levels in the ecosystem. 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 (Andersin et al. 1978, Karlson et al. 2002). While hypoxia is to some degree a natural phenomenon in the Baltic, it is also clear that the spatial and temporal extent of oxygen deficiency has increased over the past decades due to eutrophication (Karlson et al., 2002, Diaz & Rosenberg, 2008).

It seems unrealistic that BSAP targets are likely to be reached within the given time frame. Recovery is likely to take decades even though initial recovery may be fast in areas where nutrients are dramatically reduced and oxygen conditions improve.

3.4.3 Recommendations

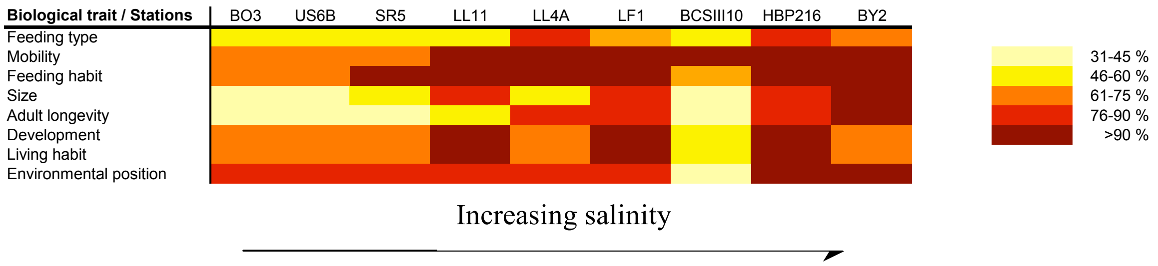
It is imperative that broad-scale monitoring of benthic macrofaunal communities in the Baltic will continue and that the frequency and intensity of current activities are not reduced. Existing time-series will be invaluable for future assessments and evaluations of environmental impacts and climate change research.

3.4 TABLES

Table 3.4.1. Stations from each sea area give examples of the benthic communities during the assessment period 2000-2006. Diversity is measured as total and average number of species ± std and Cody's measure (β) represents the average species turnover ± std. Diversity is also calculated as the Shannon & Wiener (H' (log_2)) index (Shannon & Weaver 1949).

Sea area	Station	Depth	Total nr	Average nr of species		Shannon-Wiener H' (log_2)		Cody's measure $ß_C$	
		m	of species	x	std	x	std	x	std
Bothnian Bay	BO3	110	3	1,43	0,53	0,02	0,03	0,50	0,32
Bothnian Sea, north	US6B	82	3	2,14	0,69	0,07	0,06	0,25	0,42
Bothnian Sea, south	SR5	125	5	3,86	0,90	0,88	0,37	0,17	0,26
Gulf of Finland	LL11	67	7	3,14	1,21	0,34	0,16	0,83	0,93
Gulf of Finland	LL4A	58	10	5,86	1,86	1,46	0,39	1,33	0,68
N Baltic Proper	IBSV9	88	0	0,00	0,00	0,00	0,00	0,00	0,00
NE Gotland basin	LF1	67	7	3,43	1,27	0,57	0,22	0,75	0,52
SE Gotland basin	BCSIII10	90	3	1,71	0,76	0,33	0,47	0,42	0,38
Bornholm basin	BY5	89	0	0,00	0,00	0,00	0,00	0,00	0,00
Bornholm basin	HBP216	53	13	10,00	1,63	2,16	0,40	1,33	0,58
Arkona basin	BY2	48	27	13,67	3,01	2,37	0,24	4,40	0,74

Table 3.4.2. Biological traits (BT) at selected stations in the Baltic Sea, expressed as a percentage of the total number of BT identified for respective main group during 2000-2006. The following main traits were included: feeding type, degree of mobility, feeding habit, size, adult longevity, developmental mechanism (larvae), living habit and environmental position.



3.4 FIGURES

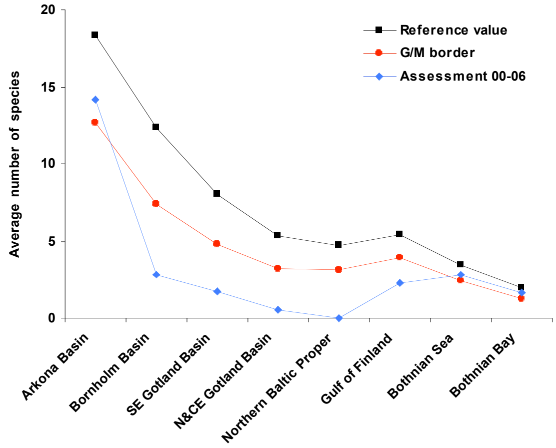


Figure 3.4.1. Reference values and the border between good and moderate (G/M) ecological status in the different sub-basins in open-sea areas of the Baltic Sea depicted as EQR and the average number of species. Benthic invertebrate status is described as an average for the assessment period (2000-2006).

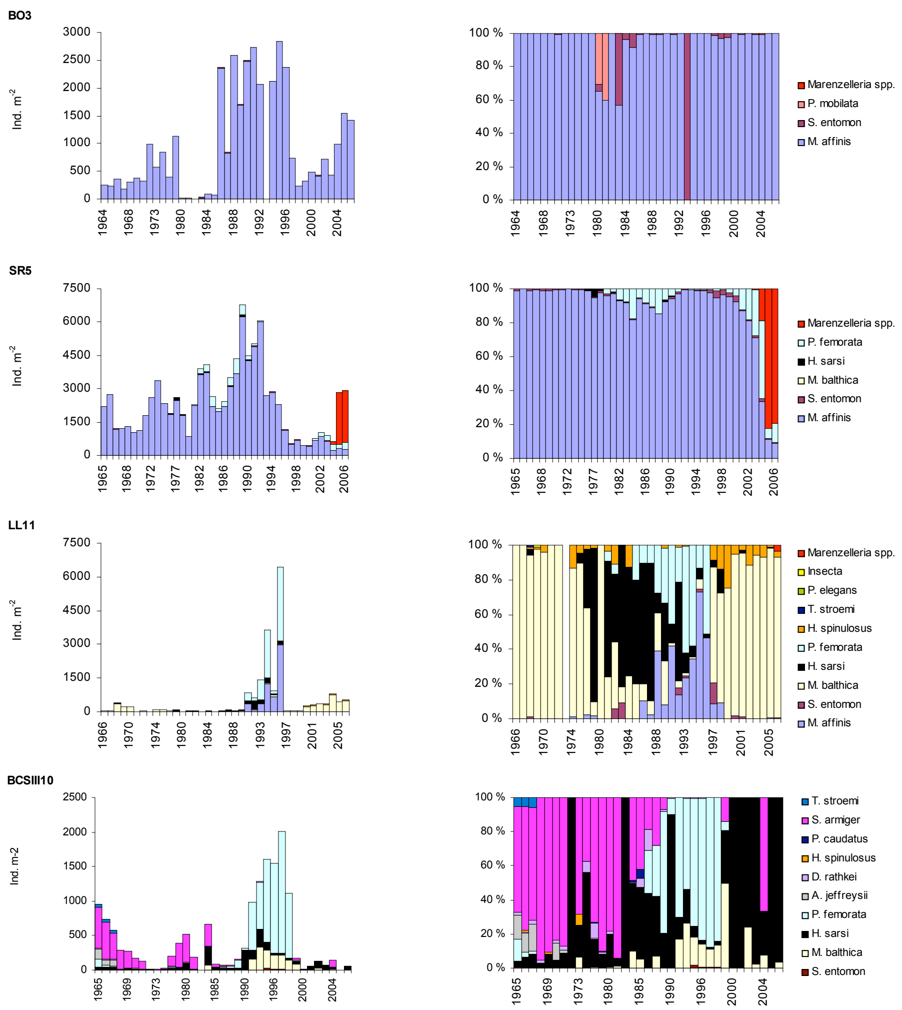


Figure 3.4.2. Long-term changes in benthic community abundance and composition (illustrating species turnover) are depicted for stations BO3 (Bothnian Bay), SR5 (Bothnian Sea), LL11 (at the entrance to the Gulf of Finland) and BCSIII10 (SE Gotland Basin). Note the different x and y –axes.

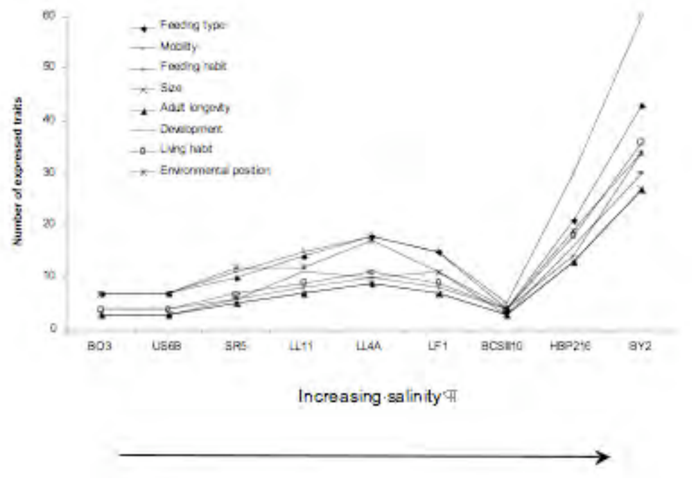


Figure 3.4.3. The number of expressed biological traits in each main group (feeding type, mobility, feeding habit, size, adult longevity, development, living habit and environmental position) during 2000-2006 for selected stations (Villnäs & Norkko, unpublished). Note that one species may express several traits, hence the amount of traits often exceed the total number of species at a station. Biological traits include (a) feeding type: suspension feeder, surface detritivore, burrowing detritivore, omnivore, carnivore, scavenger, herbivore, (b) Degree of mobility: suspension feeder, surface detritivore, burrowing detritivore, omnivore, carnivore, scaveneger, herbivore, (c) feeding habit: jawed, tentaculate, pharynx/proboscis, other mechanism, (d) size (measured in biomass): xs, s, m, l, xl, (e) Adult longevity (years): 1-2, 2-3, 3-5, 5-10, >10, (f) developmental mechanism: planktotrophic, lecitotrophic, direct (brood protection), other, (g) Living habit: tube-dweller, burrow dweller, crevice dweller, free living, and (h) Environmental position: epifaunal, infaunal, pelagic, epibenthic, nectobenthic.

3.5 Fish communities

Baltic Sea fish communities consist of representatives of various origin: marine species, freshwater species, migratory species, glacial relicts and alien species. Representatives of these categories have different preferences for environmental conditions and the composition of fish communities therefore vary in different regions of the Baltic Sea, primarily depending on salinity, water temperature, oxygen content and nutrient concentrations.

Fish perform several important roles in the ecosystem: they may act as essential consumers of plankton (especially clupeids), they may serve as a food for marine top predators (for mammals and fish-eating birds), they may substantially facilitate pelagic-benthic coupling, and they may also serve as transmitters of parasites. While the essential role of commercial fish is to provide food for man, non-commercial species may act as habitat and food competitors for commercial fish, serve as an essential food or as predators for them.

The Baltic Sea Action Plan (BSAP) addresses several issues related to fish communities. Among the biodiversity targets the following two can be highlighted: *"By 2015, to achieve viable Baltic cod populations in their natural distribution area in Baltic proper"* and *"By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species"*. The HELCOM list contain at present 23 threatened or declining species of fish and lampreys.

3.5.1 Status and trends

The total number of fish species in the Baltic Sea area is around 100. They consist of about 70 marine species, seven diadromous species (including sea- and river lamprey) and 33 freshwater species. Whereas the number of marine fish species in the North Sea is around 120, one can observe around 70 in the Kiel and Mecklenburg Bay, 40-50 in the Baltic proper, 20 in the Gulfs of Finland and Bothnia, and only 10 in the northernmost part of the Bothnian Bay. This distribution pattern is similar to the rest of the fauna and flora in the Baltic Sea area and is due to brackish water conditions with decreasing salinity from the south to the north (Nellen & Thiel 1996).

Marine fish such as plaice *Pleuronectes platessa*, cod *Gadus morhua* and flounder *Platichthys flesus*, prefer more saline areas and are therefore more abundant in southern and/or open Baltic. Freshwater fish such as perch *Perca fluviatilis*, pike *Esox lucius*, bream *Abramis brama*, and roach *Rutilus rutilus*, colonise mostly coastal areas, but also northeastern Baltic (incl. large gulfs) where the salinity is lower. Glacial relicts, for instance, eelpout *Zoarces viviparus*, lumpsucker *Cyclopterus lumpus*, fourhorned sculpin *Triglopsis quadricornis*, and sea snail *Liparis liparis* are more abundant in the cold-water layers in deeper areas and the northeastern Baltic Sea with sufficient amount of oxygen. In addition, various fish species from the North Sea migrate from time to time into the Baltic Sea. Due to unfavourable environmental factors (essentially low salinity and temperature), these fish are unable to form self-sustaining populations in the Baltic Sea and include, for instance species like whiting *Merlangus merlangus*, European anchovy *Engraulis encrasicolus*, mackrel *Scomber scombrus*, grey mullets *Liza ramada* and *Chelon labrosus*.

Marine fish

Herring, sprat and cod are the major commercial fish species in the Baltic Sea. The status of these stocks has been monitored for decades with the longest record available for the eastern Baltic cod since the mid 1940s. The eastern Baltic cod stock peaked in the late 1970s and early 1980s (Eero et al. 2007). A climate induced decrease in the cod reproductive volume, i.e. the amount of water with favourable conditions for successful hatching of cod eggs, since the 1980s has caused high cod egg mortality (Köster et al. 2003). This, together with too high fishing pressure resulted in historically low values of the cod stock since the early 1990s (ICES 2008a, Figure 3.5.1). Release of the predation pressure by cod, and accompanied with favourable hydrographic conditions have allowed the sprat stock to increase since the late 1980s, which together with herring strongly dominate the Baltic fish communities since then (Figure 3.5.2 and 3.5.3). This shift to domination of pelagic fish community represents a profound change in the marine ecosystem, also called as 'regime shift' (e.g., Alheit et al. 2005).

In addition, there are several marine non-commercial fish present in the Baltic Sea, for instance gobies *Pomatoschistus* spp., three-spined sticklebacks *Gasterosteus aculeatus*, nine-spined stickleback *Pungitius* *pungitus* and pipefish *Nerophis ophidion*. These species are adapted to inhabit mainly estuarine low-salinity areas and play several significant roles in the ecosystem. Despite their importance, the knowledge on the spatio-temporal population dynamics of these fish is relatively poor.

Freshwater fish

The most common freshwater species which are found in a majority of coastal areas of the Baltic Sea are perch, roach, ruffe *Gymnocephalus cernuus*, ide *Leuciscus idus*, pike and whitebream *Blicca bjoerkna* (Adjers et al. 2006). The most recent evidence suggests that freshwater species have exhibited different population dynamics in various parts of the Baltic Sea over the last 10-20 years from which monitoring data is available. For instance, coastal fish surveys show a significant increase in perch and roach abundance in the Archipelago Sea. This is thought to be caused by the ongoing coastal eutrophication, since these fish have been shown to be favoured by moderate eutrophication, as well as increased water temperatures (HELCOM 2006). In other areas such as the west-Estonian Archipelago Sea, the same species have significantly decreased and/or even collapsed (Figure 3.5.4). This, as well as the decline in pike and pikeperch stocks in Curonian lagoon, Daugava estuary and Pärnu Bay which all are characterised as having high level of eutrophication, have occurred due to a too high fishing pressure (Adjers et al. 2006, HELCOM 2006).

A number of community (number of species, total biomass, species diversity, slope of size spectrum and average trophic level of catch) and species (biomass, mean age, mortality, mean length and slope of size spectrum) level indicators for coastal fish were recently developed within HELCOM. Some of these indicators have been used in the pilot studies using the Biodiversity Assessment Tool BEAT (chapter 5).

Migratory species

Several migratory species are of commercial value. These are, for instance, salmon *Salmo salar*, trout *Salmo trutta*, eel *Anguilla anguilla*, vimba bream *Vimba vimba* and smelt *Osmerus eperlanus*.

Baltic salmon stocks started to decline already in the mid-19th century and since about the same time, artificial stocking activities were started. Decline of natural stocks was essentially fast since the late 1940s, because of construction of hydroelectric power plants and damming of rivers. As a result of human intervention, natural salmon production has decreased substantially during the 20th century. Furthermore, several natural stocks have disappeared. Baltic salmon catches have continued to decline also currently and they are now at their lowest level since a joint catch statistics started in the 1970s. However, the natural smolt production of salmon populations has improved in the northern Baltic rivers in recent years. The former International Baltic Sea Fisheries Commission (IBSFC) established as a management objective for wild salmon rivers to reach at least 50% of the potential smolt production by 2010. Most of the northernmost stocks are either likely or very likely to reach this objective, while the stocks in the more southern areas have slightly more varying and on average poorer status (ICES 2008b). Sea trout populations are currently in a precarious state in the Gulf of Bothnia and in the Gulf of Finland, while the populations have improved in the western part of the Baltic Sea (ICES 2008b).

The European eel stock has declined in most of the distribution area, also evidenced by substantial declines of landings in several countries of the Baltic Sea (FAO and ICES 2007). The decline is a combination of many factors among them fisheries and man-made obstacles to migration in river systems i.e. hydropower plants. The stock is currently outside safe biological limits with low recruitment indicating no obvious sign of recovery. Therefore, the current levels of anthropogenic mortality are not sustainable and should be reduced to close to zero as soon as possible (FAO and ICES 2007).

Sturgeon *Acipenser sturio* has been a very important component of local exploited fish fauna for centuries, especially in the southern Baltic (e.g., Mackowiecki 2000). Since the 11th-12th centuries, sturgeon started to decline, but was still mentioned as a commercial species in several localities in the northern Baltic Sea in the 19th-early 20th century (e.g., Schneider 1912). Currently, sturgeon is a red-listed fish in the Baltic Sea and virtually extinct and a reintroduction programme has been initiated (Box 3.5.1).

Alien species

Several alien fish (e.g., rainbow trout *Oncorhynchus mykiss*, gibel carp *Carassius gibelio*, round goby *Neogobius melanostomus*) are common and found in exploitable quantities in various sub-systems of the Baltic Sea. Many alien fish species were introduced into the Baltic Sea during the 1950s-1970s. The list includes for example the sterlet *Acipenser ruthenus*, the beluga *Huso huso*, the Siberian sturgeon *A. baeri*, and the Russian sturgeon *A. gueldenstaedtii*, the chum salmon *Oncorhynchus keta* and the pink salmon *O. gorbusha*. In addition, species like *Oncorhynchus mykiss*, *Coregonus autumnalis migratorius*, *C. nasus*, *C. muksun*, *C. peled*, *Catostomus catostomus*, *Perccottus glenii*, silver carp *Hypophthalmichthys molitrix* and spotted silver carp *Aristichthys nobilis* have been found as rare findings only (Repecka 2003, Leppäkoski et al. 2002, Ojaveer 1995). However, none of these species have been able to form self-sustaining populations. There are, however, two fish species that are of concern; the round goby *N. melanostomus* (introduced in the early 1990s) and the Prussian carp *C. gibelio* (present in the Baltic Sea since the early 1950s). They have been shown to reproduce in the Baltic Sea, have colonised new areas during the recent decades, are increasing in abundance in various parts of the Baltic Sea and have received commercial status (Vetemaa et al. 2005, Corkum et al. 2004).

Glacial relicts

Our present knowledge on population status and trends of glacial relict fish species is very scarce. These species require cold and oxygen rich water and are present in relatively low abundances with the main distribution in deep areas of the northeastern Baltic Sea. In the Baltic Sea, these fish are mostly non-commercial species with exception of eelpout that has some commercial importance. There are evidences that abundance dynamics of these species is negatively influenced by excessive eutrophication, contamination of toxic substances and presence of large marine predators (Ojaveer 1995). It should be stressed here that this category of fish represent a specific trophic function in the Baltic being the only permanent potentially abundant vertebrate predator in the cold-water environment in deep areas.

3.5.2 Conclusions

Fish communities are currently unbalanced in several areas of the Baltic Sea. This is evidenced by significant declines or in some cases complete lack of large predatory fish in the system, further increase in warm-water preferring and eutrophication tolerating species, and decrease in several valuable commercial fish stocks. The status of several fish is of concern, mostly related to the BSAP community level. The concern is especially valid for the most valuable exploited species both in the open and coastal sea, because of too intense fishing. The present knowledge on non-commercial fish is relatively scarce and deserves further attention. Several presently threatened/declining species are highly susceptible to eutrophication and pollution, problems that are still considerable in many areas of the Baltic Sea. In order to achieve community and species level targets, the factors listed above (i.e. fishing pressure and eutrophication/pollution), together with naturally driven factors (climate variability) and bioinvasions need to be taken into account when managing fisheries. However, a more detailed evaluation is needed to judge whether the whole list of fish related targets of the BSAP are actually achievable within the indicated time-frame.

3.5.3 Recommendations

One of the critical limitations to properly assess the structure and function of the Baltic fish communities is shortage or in some cases almost complete lack of information on non-commercial fish. Thus, it is recommended to enhance the knowledge-base on this category of fish by development of relevant sampling methodology to study amongst others, the distribution, abundance, structure and trophic interactions.

3.5 FIGURES

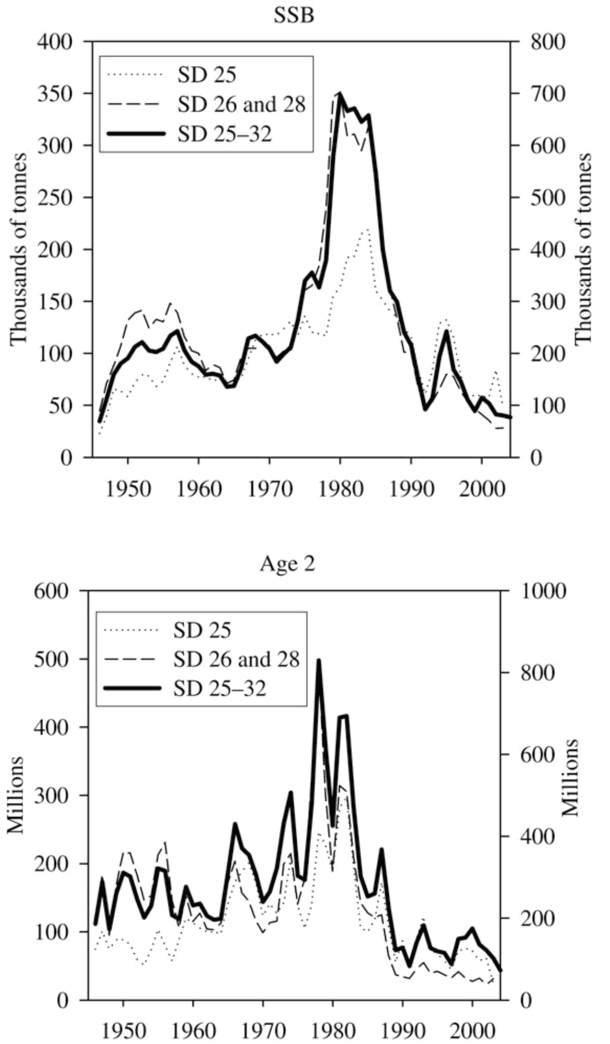


Figure 3.5.1. Spawning stock biomass (SSB, in thousand tons) and recruitment (age 2, millions) of cod in ICES SDs 25–32 and separately for SD 25 and SDs 26 and 28 from the mid-1940s. The left axis refers to the separate SDs, the right to the entire stock (Eero et al. 2007). A map of ICES subdivisions is provided in chapter 6, Fisheries, Figure 6.1.1.

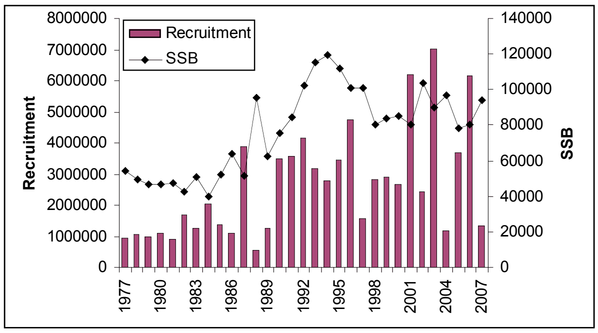


Figure 3.5.2. Recruitment (R, age 1 in thousands) and spawning stock biomass (SSB, in tonnes) of the Gulf of Riga herring during 1977-2007 (ICES 2008a).

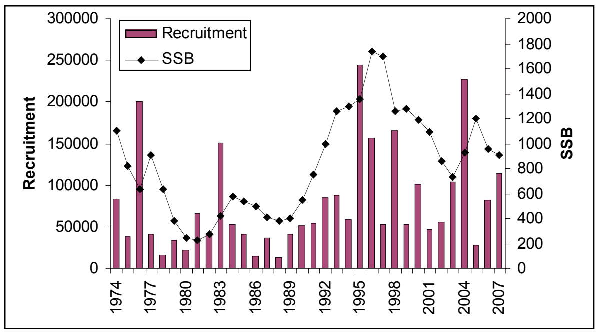


Figure 3.5.3. Recruitment (R, age 1 in millions) and spawning stock biomass (SSB, in thousand tonnes) of sprat in the Baltic Sea (ICES SD 22-32) during 1974-2007 (ICES 2008a).

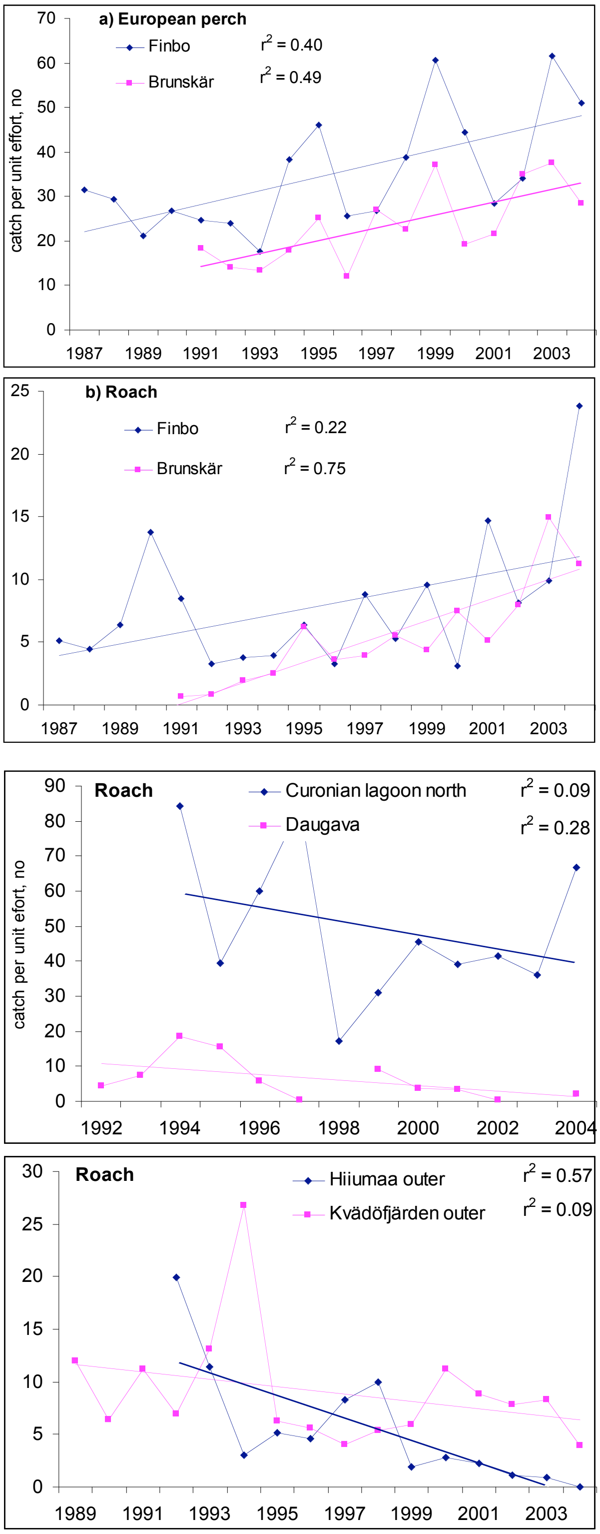


Figure 3.5.4. Dynamics of catch per unit effort (CPUE) of perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*) in various localities of the Baltic Sea (HELCOM 2006).

3.5 BOXES

Box 3.5.1. Sturgeon re-introduction programme

Until the 19th century Atlantic sturgeon (*Acipenser oxyrinchus*) was widely distributed in the Baltic Sea and its southern tributaries. Its decline was caused by over fishing and regulation as well as pollution of rivers. As a result, the last sturgeon in the Baltic Sea was caught in Estonia in 1996 (Paaver 1997).

The attempts to remediate its population in the Baltic started under the auspices of HELCOM in 1996. While focusing on the highly endangered *Acipenser sturio* in the first years, genetic and morphological evidence that the Baltic sturgeon resulted from colonization of the area by the North American Atlantic sturgeon (*Acipenser oxyrinchus*) approximately 1200 before present (Ludwig et al. 2002) resulted in dynamic attempts for remediation of the Atlantic sturgeon. In order to facilitate its reintroduction into the Baltic Sea and its catchments, different strategies were applied. The transport of early life stages for rearing of broodstock and experimental release as well as transfer of adult fish for broodstock development has taken place since 1998 in increasing intensity both in Germany and Poland. This material originated from the natural population of the St. John River, being genetically closely related to the historic Baltic sturgeon.

Along with broodstock rearing, research on the behaviour of juveniles in their natural habitat has been carried out in experimental release programmes since 2006. For these purposes mainly the Drawa (Odra River tributary) and the Drwęca (Vistula River tributary) rivers have been utilized. In the past, these rivers included sturgeon reproduction sites and habitat for early life stages while having maintained sufficient ecological conditions for sturgeons until today.

Under the bilateral Polish-German cooperation more than 7 000 individuals of Atlantic sturgeon were released into the Odra and the Vistula tributaries in 2007 while in 2008 more than 35 000 sturgeons were released. The sizes varied from 1.5 cm to 70 cm in an attempt to identify their suitability for release. Released fish were equipped with Floy or Carlin tags. Additional 150 fish were marked with transmitters to determine their migration routes.

All marked sturgeons regardless of size released in the upriver sections had a tendency to migrate downstream immediately, entering coastal waters over time. Pronounced individual differences were observed with regard to migration speed both in telemetry studies as well as in fisheries reports. The presence of the first sturgeon in the Gulf of Gdansk as well as in the Pomeranian Bight was noted only 10 days after the release, with maximum distances of 400 km covered during this time-span. According to the information from the fishery, sturgeons spent two or more weeks at the river mouth foraging intensively. This resulted in quick growth, being a clear evidence for the abundance of food resources available (Kolman 2008).

The results of the Polish-German project suggest that there is a significant chance for success of future reintroduction work. Fry of the Baltic sturgeon can adapt easily to the environmental conditions in the rivers and in the Gulf of Gdansk.

CHAPTER 4: SPECIES

Overall, the species of the Baltic Sea amounts to a couple of thousands, with the majority belonging to the phyto- and zooplankton community. For the smallest species, i.e. bacteria and viruses, the diversity is largely unknown. The evaluation of Baltic Sea diversity is primarily focused on indicators that often are represented by selected species.

In this assessment, species have foremost been addressed as representatives of the Baltic Sea communities (see Chapter 3). This chapter includes a special set of species that are either threatened (Box 4.1) or associated with specific targets in the Baltic Sea Action Plan (BSAP). Particular attention is given to the population of harbour porpoise, seals and a selection of birds. The specific targets of the action plan related to the respective species or species group are discussed and recommendations provided accordingly.

4.1 Harbour porpoise

The harbour porpoise (*Phocoena phocoena*) occurs in the temperate and sub-arctic zone of the Northern hemisphere. It is the only cetacean species inhabiting, i.e. reproducing, in the Baltic Sea. As top predator the harbour porpoise is an indicator species for the environmental condition of the Baltic Sea. Two distinct populations are differentiated in this area apart from the North Sea/Skagerrak population by means of genetical and morphological differences: one inhabits the Kattegat and western Baltic Sea possibly up to the Arkona Basin, while the other population inhabits the Baltic Proper (e.g. Huggenberger et al. 2002, Tiedemann et al. 1996). Research on boundaries and distribution of these separate populations is ongoing.

Up to the early 20th century the harbour porpoise was common and widely distributed throughout the Baltic Sea (Tomilin 1957, cited in Koschinski, 2002). Concurrent with a declining population, the distribution limits gradually receded west and southward over the past decades (Koschinski 2002). The recent abundance of this species in the Baltic Proper is low.

International bodies such as the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), the International Whaling Commission (IWC), the International Union for Conservation of Nature (IUCN) and the Helsinki Commission (HELCOM) have recognised the need for an action plan to recover the Baltic harbour porpoise. In 2002, the ASCOBANS recovery plan (aka Jastarnia Plan) was created with an interim goal to restore the population of harbour porpoises in the Baltic Sea to at least 80% of its carrying-capacity level (ASCOBANS 2002). The objectives of the recovery plan are to implement precautionary management measures e.g. to reduce the by-catch rate to two or fewer porpoises per year.

The Baltic Sea Action Plan (BSAP) targets an improved conservation status of the Baltic harbour porpoise by 2015. The HELCOM aim is a significant reduction of harbour porpoise by-catch rates close to zero by 2015. In co-operation with ASCOBANS, a coordinated reporting system and a database on Baltic harbour porpoise sightings, by-catches and strandings is to be developed to increase the knowledge on and protection of this species by 2010.

4.1.1 Status and trends

The harbour porpoise population inhabiting the Baltic Proper has been classified as “vulnerable” (IUCN, 1996). Although neither the original population size nor the carrying capacity of the Baltic Proper has been quantified, it appears likely that the population size decreased by over 90% in the 20th century due to anthropogenic impact. The remaining population is considered to be small (< 250 mature individuals) and continues to decline, which would justify the classification as “critically endangered” under IUCN Red List criteria (Hoffmann et al. 2008).

The harbour porpoise density and abundance in the western Baltic Sea and the Kattegat has been estimated in a number of studies during the last 15 years, primarily by conducting visual surveys from ships or aircrafts but also by using acoustic survey methods (for details see Table 4.1.1, Figure 4.1.1). Reported sightings and stranding provide additional information on the distribution of the harbour porpoise.

Abundance and distribution

For a survey area in the Skagerrak, Kattegat and the northern part of the Western Baltic, the mean abundance of harbour porpoise was estimated to be about 36 000 animals in July 1994 (Hammond et al. 2002). In the southern Belt Sea and the Arkona Sea, mean abundance estimates range from 1 350 to 2 900 animals for the years 2003 to 2006 and show seasonal differences in harbour porpoise abundance (Gilles et al. 2008). A total abundance of 599 porpoises were estimated in the Arkona Sea and the southern Baltic Proper in June 1995 (Hiby & Lovell 1996, cited in Berggren et al. 2004). This survey was repeated in 2002 resulting in a mean estimate of 93 porpoise groups (Berggren et al. 2004). The two estimates are not significantly different from each other due to the wide confidence intervals of both surveys, but confirm the low porpoise abundance in the Baltic Proper.

The results of the mentioned studies are given in Table 4.1.1 and Figure 4.1.1. They are not directly comparable to each other due to differences in survey area and season. Furthermore, porpoise abundance in such low densities can only be estimated with large uncertainty. Nevertheless, a decrease in harbour porpoise densities from the Kattegat and Belt Sea eastward is obvious (e.g. Gilles et al. 2008, Gillespie et al. 2005).

A number of aerial surveys conducted in the Arkona Sea or the southern Baltic Proper (e.g. Berggren et al. 2004, Gilles et al. 2008, Table 4.1.1) also resulted in very low to zero sighting rates, mirroring extremely low harbour porpoise densities. In such low density areas, acoustic survey methods may give a better indication of porpoise densities. Static passive acoustic monitoring from 2002 to 2007 showed annually recurring seasonal changes in German waters with low porpoise densities during winter and high densities during summer and autumn, indicating the occurrence of seasonal migrations in the western Baltic population (Verfuß et al. 2008). The gradient in porpoise densities from west to east was detectable for each season.

Sightings and strandings

Although porpoise density in the Proper Baltic is extremely low, it is important to point out that by-catch and occasional opportunistic sightings of harbour porpoises prove the continued presence of this species in nearly all parts of the Baltic Sea. Opportunistic sightings and strandings of harbour porpoises have been reported in almost all countries surrounding the Baltic Sea. The non-governmental organization Coalition Clean Baltic for the Protection of the Baltic Sea (CCB) collated number and distribution of such reports for the years 1950-2005 (Table 4.1.2). A number of data banks collect information about incidental sightings and strandings of harbour porpoises in the Baltic Sea (see reference list).

Carlén (2005) reported 146 live sightings of harbour porpoises in Swedish waters between May 2003 and September 2004, with three of those located along the Swedish east coast along the Baltic Proper. In Polish waters, a total of 10 sightings were reported for 1990-1999 (Skóra & Kuklik 2003). Sighting rates in Danish and German waters are higher in summer than in winter (Kinze et al. 2003, Siebert et al. 2006).

Annual totals of 110, 139 and 107 strandings were reported for the Danish coasts (mostly in the HELCOM area) for the years 2000 to 2002, respectively (Kinze et al. 2003). Along the German coast, 11 to 64 strandings were reported annually for the years 1990-2005 (Figure 4.1.2). Skóra & Kuklik (2003) recorded seven strandings for the Polish coast during the years 1990-1999. Such information constitutes minimum numbers as not all sightings and strandings are being reported.

4.1.2 Factors influencing the state of the harbour porpoise

Several human activities influence the state of the harbour porpoise negatively. The most important anthropogenic threats to harbour porpoises are the incidental by-catch, prey depletion, noise pollution and chemical toxins.

Incidental by-catch in fishing gear leads to suffocation and death (which is why driftnets have already been prohibited). In general, by-catch depends on the fishing methods and the fishing effort employed whereas the reported number of by-caught porpoises depends on the awareness and willingness of fishermen. Already the minimum estimates of by-catches (see Table 4.1.2 and chapter 6, Fisheries) exceed the mortality limits for the population of the Baltic Proper by far, indicating that these by-catches will prevent recovery (Berggren et al. 2002).

Prey depletion due to over-fishing and habitat destruction is known to lead to starvation and the deterioration of health (e.g. MacLeod et al. 2007)

Noise pollution from industrial and military sources may lead to habitat exclusion, hearing loss or death (see chapter 6, Noise pollution). Before-After-Control-Impact (BACI) studies during wind park constructions in the Danish Baltic Sea showed a lasting reduction in acoustic recordings mirroring a drastic reduction in porpoise abundance in the area (Carstensen et al. 2006). Furthermore, noise simulations show that operating turbines may have a masking effect at short ranges in the open sea (Lucke et al. 2007).

Chemical toxins such as persistent organic pollutants and heavy metals may lead to reduced fertility, reduced immune response and illness. PCB-related reproductive failure is well known from Baltic grey seals (e.g. Bergmann 1999). A strong increase in infectious disease mortality was shown in British harbour porpoises to correlate with PCB levels above 17 mg/kg lipid (Jepson et al. 2005). Beineke et al. (2005) also found indications for contaminant-induced immunosuppression in stranded harbour porpoises at the German Baltic coast.

4.1.3 Conclusions

The harbour porpoise density and distribution has declined considerably during the last several decades, leading to a vulnerable (possibly “critically endangered”) status of the distinct harbour porpoise population in the Baltic Proper. Several human activities influence the status of the harbour porpoise negatively and without the reduction of these anthropogenic impacts to tolerable levels, the targets for the Jastarnia Plan and BSAP appear unlikely to reach.

The European Union has adopted some measures to protect harbour porpoise within the Habitats Directive (1992) (European Commission, 1992) and in EC Regulation No.812/2004 (European Commission, 2004). The former asks for the introduction of marine protected areas as well as conservation measures in the entire porpoise distribution range and the latter for the elimination of drift netting. For set netting, however, only the introduction of pingers and observers in a tiny portion of the fishing fleet (5% of the vessels above 12 m and 15 m of hull length, respectively) is required. Regarding the effectiveness of this EC Regulation, strong doubts exist both among fishermen as well as among conservationists (see Stralsund Recommendations, 2007; ECS Resolution (European Cetacean Society, 2008), and the recommendation of the Jastarnia Group).

4.1.4 Recommendations

A number of mitigation measures have been suggested for the threats harming the harbour porpoise population:

By-catch reduction close to zero calls for the elimination of any contact of porpoises with the responsible gear. This can be done by a constant reduction of fishing effort or by using fishing gear less prone to by-catch. The use of deterrent devices in set nets, so-called pingers, may either be not very efficient or lead to exclusion from key habitats, should they work effectively. Therefore, ASCOBANS recommends their use only for up to three years to buy time for the development of a proper mitigation measures. Onboard monitoring of the fisheries is a prerequisite to obtain reliable by-catch numbers and to evaluate the efficiency of any mitigation measure.

A reduction of fishing effort in the responsible fisheries (at least at certain critical times) appears to be the only available mitigation measure for prey depletion due to over-fishing and habitat destruction.

Noise pollution may be reduced by limiting the maximum speed of vessels, as sound pressure levels increase with increasing vessel speed. Furthermore, fast ferries as well as jet skies should be prohibited in key porpoise areas. The latter measures would also help to avoid the danger of collisions also known as ship strikes.

Information on the harbour porpoise population status is mainly available for the Western Baltic Sea and the western part of the Southern Baltic Proper. For the Baltic harbour porpoise population, information is scarce and increased monitoring and research is therefore strongly recommended. A long-term passive acoustic monitoring in the entire Baltic Proper with stationary devices is recommended to survey harbour porpoise densities and their trends. Continuation of post-mortem investigations will supply information on the impact of chemical toxins on this top predator. The monitoring of by-catch and the development of mitigation measures continues to be essential.

4.1 TABLES

Table 4.1.1. Results of dedicated aerial and shipboard surveys (visual and acoustic) for harbour porpoises in the Baltic Sea. Study areas of the different investigations are given in Figure 4.1.1. CV: coefficient of variance, CI: confidence interval; SE: standard error.

SOURCE	PLATFORM, METHOD	DATE	AREA	Animal (A) / Pod (P) ABUNDANCE			DENSITY	
			(see Fig. 1)	Mean (CV)	CI	A/P	Mean (SE)	Unit
Hammond et al. 2002	ship, visual	July 1994	I (incl. I')	36 046 (0.34)		A	0.725	animals/km?
			I'	5 262 (0.25)			0.644	
			X	588 (0.48)			0.101	
Siebert et al. 2006	plane, visual	October 1995	B	980	360-2 880	A		
			C	601	233-2 684			
		July 1996	B	1 830	960-3 840			
			C	0	-			
Hiby & Lovell, 1996	plane, visual	June 1995	tracklines[a]	599 (0.57)	200-3 300	P		
Gillespie et al. 2005	ship, visual	June-August 2002	1				8.2	sighted groups/100 km
			2				1.03	
			3				0	
			4				0	
		August-September 2001	5				0.34	
Gillespie et al. 2005	ship, acoustic	June-August 2002	1				16.8 (3.71)	detections/100 km
			2				10.5 (1.96)	
			3				3.2 (0.75)	
			4				0.1 (0.08)	
		August-September 2001	5				0	
Berggren et al. 2004	plane, visual	July 2002	tracklines	93	10-460	P		
Gilles et al. 2008	plane, visual	June 2005	E+F+G	2 905 (0.41)	1 308-6 384	A		
SCANS-II, 2008	plane, ship, visual	July 2005	S	23 227 (0.36)		A	0.340	animals/km^2

[b] The area covered by Hiby & Lovell (1996) is comparable to that covered by Berggren et al. (2004) excluding Polish coastal waters

Table 4.1.2. Number of dead porpoises in total/by-caught reported from the central Baltic Sea by countries in 1950-2005 (adapted from Coalition Clean Baltic 2006. The Baltic Harbour Porpoise Needs Protection! Coalition Clean Baltic, Uppsala, Sweden.; data source: ASCOBANS reports).

<table>
<tr><th>Years</th><th>Sweden</th><th>Germany</th><th>Poland</th><th>Russia</th><th>Lithuania</th><th>Latvia</th><th>Estonia</th><th>Finland</th></tr>
<tr><td>1950-1959</td><td></td><td>7 / 2</td><td>8 / 5</td><td></td><td></td><td></td><td>5 / ?</td><td></td></tr>
<tr><td>1960-1969</td><td>50 / 50</td><td>14 / ?</td><td>8 / 2</td><td></td><td></td><td>1 / 1</td><td rowspan="2">6 / ?</td><td>25 / ?</td></tr>
<tr><td>1970-1979</td><td>7 / 6</td><td>13 / 2</td><td>6 / 3</td><td></td><td></td><td>1 / 1</td><td>10 / 6</td></tr>
<tr><td>1980-1989</td><td>35 / 27</td><td>36 / 2</td><td>7 / 6</td><td>1 / 1</td><td>1 / 0</td><td></td><td rowspan="2">3 / 3</td><td>1 / ?</td></tr>
<tr><td>1990-1999</td><td>17 / 14</td><td>49 / 2</td><td>62 / 45</td><td></td><td></td><td>1 / 1</td><td></td></tr>
<tr><td>2000-2005</td><td>16 / 0</td><td>40 / 5</td><td>25 / 18</td><td></td><td>2 / 2</td><td>1 / 1</td><td></td><td>17 / 0</td></tr>
<tr><td>Total</td><td>125 / 97</td><td>159 / 13</td><td>116 / 79</td><td>1 / 1</td><td>3 / 2</td><td>4 / 4</td><td>14 / ?</td><td>53 / ?</td></tr>
</table>

4.1 FIGURES

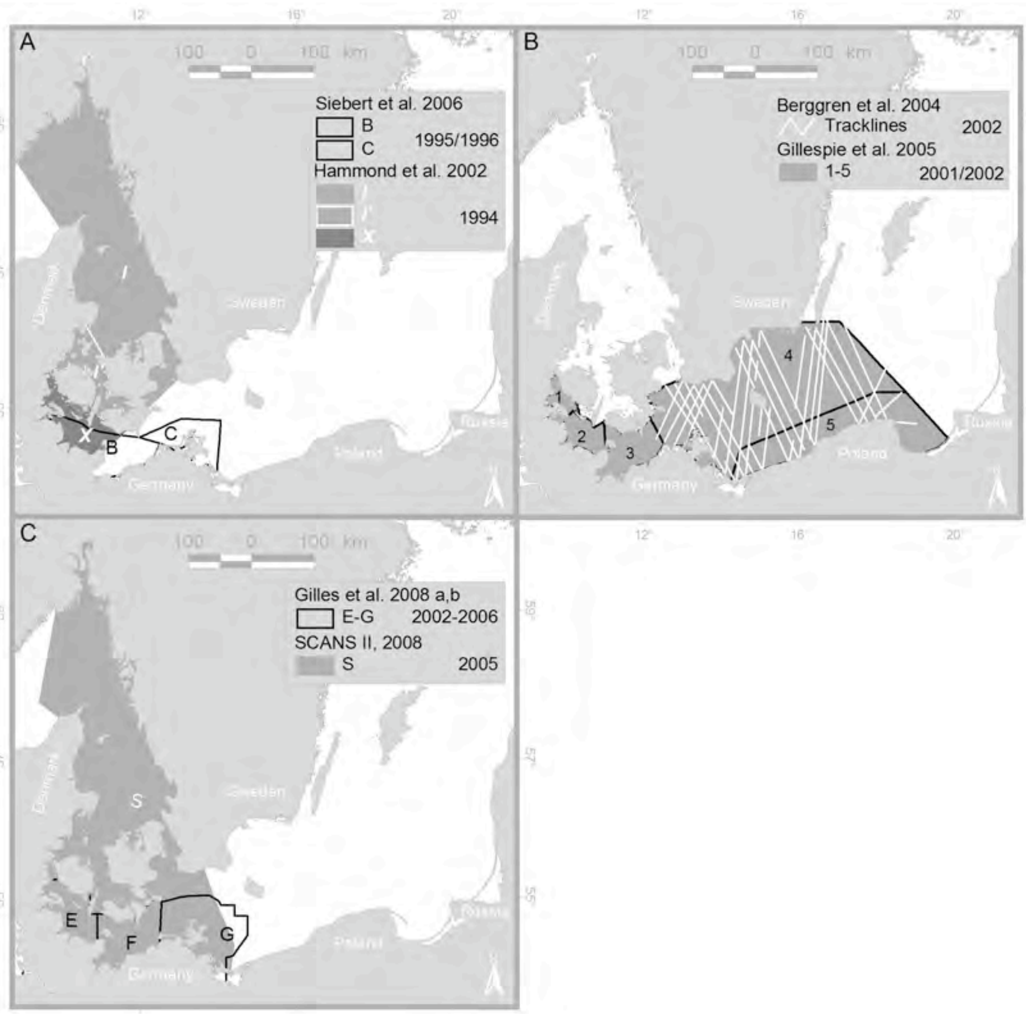


Figure 4.1.1. Survey areas of the studies listed in Table 4.1.1. The area of Hiby & Lovell (1996) (not shown) matches the survey area of Berggren et al. (2004) shown in (B) excluding a narrow area along the Polish coast. Survey area I' of Hammond et al. (2002) (in A) is part of survey area I.

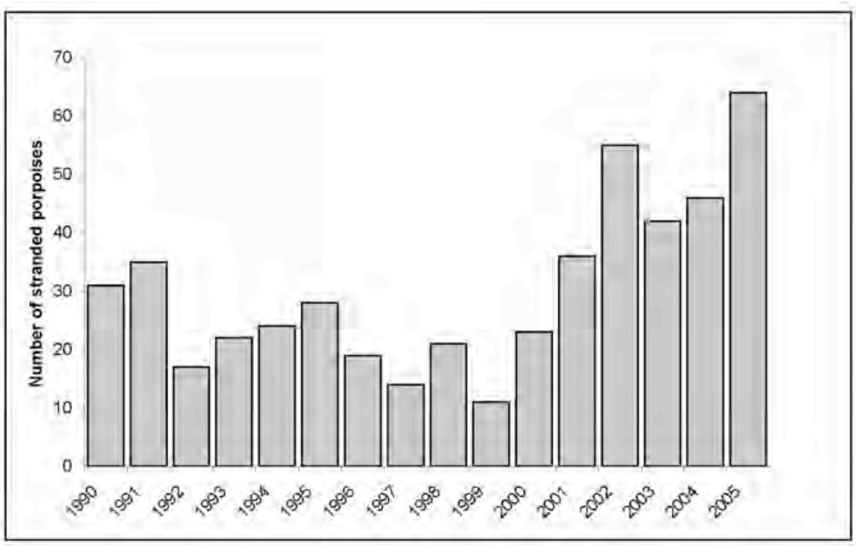


Figure 4.1.2. Number of stranded harbour porpoises recorded at the German Baltic Sea coast between the years 1990 and 2005. (Sources: Siebert et al. (2008) Unpublished report to the Ministry for Agriculture, the Environment and Rural Areas; the data-base of the German Oceanographic Museum, Stralsund).

4.2 Seals

Ringed seals (*Phoca hispida*) were common in the Baltic Ice Lake (10 000 -12 000 years ago), whereas grey seals (*Halichoerus grypus*) are suggested to have colonised the basin during the Yoldia stage (9 500-10 000 years ago). Harbour seals (*Phoca vitulina*) and probably harp seals (*Phoca groenlandica*) entered into the system some 8 000 years ago coinciding with the formation of the Litorina Sea. Except for the harp seal that disappeared during the early Iron Age, the other species have remained important top consumers in the Baltic ecosystem (Härkönen et al. 2005, BACC 2008).

All Baltic seals have been hunted ever since the Stone Age, and it is evident that they formed an important role in the diet of settlers in coastal communities. During the 15th and 16th century seals were mainly hunted for production of seal oil, which was exported to the Hanseatic League. Seal oil shipped from Sweden-Finland in the 1560s constituted the third most important export product (after metals and tar) and it is suggested that a minimum of 15 000 seals were killed each year for that purpose. Sealing remained important for coastal communities until the 1860s, when cheaper alternatives to seal oil became available. The intensive hunting during the first half of the 20th century was mainly driven by bounty systems, where the bounty for one seal initially was equivalent to a weekly wage for an industrial worker. The explicit aim of the campaign was to exterminate the seals, which were seen as competitors to the fishery.

The current HELCOM seal recommendation from 2006 states that the long-term objectives for the management of Baltic seals are natural abundance and distribution and a health status that ensures their future persistence. There are also two targets of the Baltic Sea Action Plan (BSAP) directly linked to seals. Firstly, the BSAP stipulates that *"By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species"*. All three Baltic seal species are included in this list. An additional target is directly related to by-catches in fisheries i.e. *"By 2015 by-catch of harbour porpoise, seals, water birds and non-target fish species has been significantly reduced with the aim to reach by-catch rates close to zero"*.

4.2.1 Status and trends

Ringed seals

The ringed seal is an Arctic species, and its reproduction and moulting is tightly linked to the occurrence and quality of ice and snow. The Baltic ringed seal (*P. h. botnica*) is therefore mainly distributed in the Bothnian Bay, the Gulf of Finland, the Archipelago Sea, and the Gulf of Riga as well as in Estonian coastal waters, where suitable ice and snow cover is formed annually. The main breeding season also coincides with the maximum ice coverage in February- March.

The current Baltic ringed seal population is distributed in the Bothnian Bay (70%) the Archipelago Sea (<5%), the Gulf of Finland (<5%) and in Estonian coastal waters including the Gulf of Riga (20%). Data from the bounty hunting in the 20th century suggest that the initial population size 100 years ago was 180 000 to 200 000 (Harding & Härkönen 1999). The hunting caused a main decline to about 25 000 ringed seals in the 1940s, and this level was kept relatively constant until the 1960s, when a further decline to some 5 000 animals was caused by organochlorine pollution (Harding & Härkönen 1999). In the mid 1970s only 15% of investigated females showed normal fertility (Helle 1980), which likely drove the population decline. Since then, the situation in the Bothnian Bay has improved, but still about 20% of adult ringed seal females suffer from uterine occlusion (Helle et al. 2005). The reproductive situation is mainly unknown for ringed seals in the Gulf of Finland and Estonian coastal waters.

Surveys of ringed seals in the Bothnian Bay started in the 1980s, suggesting some 2 000-3 000 seals (Helle 1986). Regular annual surveys have been carried out since 1988, and the trend of 4.3% annual increase up to 2007 (Figure 4.2.1) is about half of what can be expected in a depleted healthy ringed seal population. Counted numbers on ice in the Bothnian Bay were 4 800 in 2007.

Data from the Gulf of Finland and Estonia are scarcer, since only three full surveys from air have been carried out in the area. However, this data suggest a growth rate close to zero in both regions at least since 1996. Counted numbers in the Gulf of Finland are about 300 animals, whereas about 1 500 are suggested to haul out during moult in Estonia (Härkönen et al. 1998, Ivar Jussi pers. comm.). About 150 ringed seals have been counted in the Archipelago Sea (Antti Halkka pers. com), which totals a counted population size of close to 7 000 ringed seals.

Grey seals

The main concentrations of grey seals are found in the northern part of the Baltic Proper, although single individuals or scattered groups can be seen throughout the Baltic. Wintertime, the northern distribution is limited to areas with open waters. Baltic grey seals give birth in February-March and alternate between breeding on land sites and on open ice. However, when available, ice is preferred since pup mortality and quality is much poorer when born on land (Jussi et al. 2008).

Also grey seals were hunted heavily in the beginning of the 20th century and the earlier abundant grey seals in the Kattegat and the Southern Baltic were exterminated by hunting in the 1930s. The estimated total population of greys seals dropped from 90 000 grey seals to about 20 000 before 1940. A further decline occurred in the 1960s as in ringed seals, and perhaps only 2 500-3 000 remained in the end of the 1970s (Harding & Härkönen 1999). Several lines of evidence indicate that environmental pollution severely affected also this population. Uterine disorders (occlusions or stenosis), probably as a result of fetal death, uterine tumors (leiomyomas), hormonal disturbances (adrenocortical hyperplasia), arteriosclerosis, occurrence of skull, renal, intestinal and integumental lesions were suggested to be caused by organochlorines (Bergman & Olsson 1986, Bergman et al. 1992, Bergman 1999, Bäcklin et al. 2003, Bredhult et al. 2008).

The prevalence of uterine disorders has dropped considerably during the last two decades and other lesions have also decreased somewhat, but the prevalence of colonic ulcers has increased since the mid 1980s and the nutritive condition of grey seals appears to have diminished recently (e.g. Bergman, 1999, Bäcklin et al. 2007, Routti et al. 2008).

There have not been fully coordinated surveys of grey seals until very recently. Survey methods have changed in time and gradually improved, which precludes an over-all assessment of the population growth rate of the entire Baltic grey seal population. The only longer time series providing compatible data is for the Swedish coastal waters. The mean annual rate of increase in the period 1990-2005 was about 8% (Figure 4.2.2), which is somewhat less than the theoretical maximum growth rate of 10% for the species (Harding et al. 2007). Surveys from air carried out in 2006 and 2007 give higher estimates of abundance, but it will take at least six years until such data can provide useful information for trend analyses (Harding et al. 2007).

The recovery of grey seals south of 59º North, where they had been regularly present before they were hunted to extinction in the beginning of the 20th century is very slow (Herrmann et al. in prep). Although grey seals are observed more often than 10 years ago, no residental colonies are reported in the Southern Baltic coast (from Germany to Latvia).

Harbour seals

Harbour seals only occur in the southern part of the Baltic and there are no historical records of harbour seals north of the line Västervik (Sweden) to Hiiumaa in Estonia. The harbour seals in the Kalmarsund region are genetically distinct from adjacent populations with gene sequences only present in this population. The current harbour seal population in Southwestern Baltic (Scania and Denmark) seems to have colonised the area after the grey seals were severely depleted in the 1750s. Harbour seals reproduce in June, mate in July and moult in July-August.

Harbour seals in the Kalmarsund were close to extinction in the 1970s. Hunting, possibly in combination with effects of contaminants, resulted in a severe bottle-neck and only some tens of pups were observed in the beginning of the 1970s (Härkönen et al. 2005). After protective measures were taken and seal sanctuaries were established in the 1980s and 1990s, the population has increased by 7% per year up to 2007, when 630 seals were counted during moult. Also the pup production shows a similar positive trend and close to 100 pups were born in 2007. Since harbour seals in this area spend about 65% of their time on land the true population size is close to 1 000 seals. There is basically no information on the health status of this population.

Harbour seals in the southern Baltic, the Kattegat and the Skagerrak also declined steeply in the beginning of the 20th century as a consequence of the coordinated Nordic extermination effort. Bounty statistics suggest that more than 17 000 harbour seals were present in the area in 1890, but only about 2 000 seals remained in the end of the 1930s (Heide-Jørgensen & Härkönen 1988). Heavy hunting pressure kept the population at this level until the beginning of the 1970s, when hunting was prohibited, and seal conservation areas were established. Annual surveys of the population started in 1979 and the population increased at 12% per year until 1988 when it was hit by a phocine distemper virus (PDV) epidemic that killed about half the population. Subsequently, the population increased exponentially at 13% per year until a new PDV epidemic in 2002 killed 66% of the seals in the Skagerrak and 30% in the Kattegat (Härkönen et al. 2006). A third epidemic caused by an unknown pathogen appeared in 2007 and killed some thousands of seals, but the total impact cannot be evaluated until survey results from 2008 become available. The total "true" population size was about 15 000 in 2007, but this number should be regarded as uncertain since seals can have died in great numbers after the surveys in 2007 were conducted.

The reproductive status of this population appears to be normal since 95% of mature females reproduce, and the population growth rate is close to maximum levels for the species. However, the material collected in 1988 showed high prevalences of bone lesions (parodontitis and alveolar exostosis) (Mortensen et al. 1992). Alveolar exostosis is not present in material collected before 1950. Furthermore, experimental studies have shown that harbour seals carrying PCB loads comparable with levels observed in the Kattegat show impaired immune functions (DeSwart 1996).

4.2.2 Factors that influence the state of seals in the Baltic Sea

The current and future state of Baltic seals is, and can be expected to be affected by a number of anthropogenic factors.

Xenobiotic substances have had a severe impact on health and abundance of ringed and grey seals, and also affect hormonal processes in harbour seals. The multitude of chemical substances produced poses a potential threat to the health of all top consumers in the Baltic biota (Bergman & Olsson 1986, Bergman et al. 1992, Bergman 1999, Bäcklin et al. 2003, Bredhult et al. 2008).

Unsustainable management of fish stocks can lead to depletion of important food organisms for marine mammals in the Baltic. The currently decreasing blubber thickness in grey seals (Figure 4.2.3) and ringed seals (Britt-Marie Bäcklin pers. comm.) may be linked to such effects. Similar effects are suspected in the Kattegat, where the population growth rate declined the years before the 2002 PDV epidemic.

By-catches in fisheries reduce the growth rate in populations of marine mammals, which increases the risk for rapid declines in most scenarios in ecological risk analyses (Hansson et al. in prep.). No systematic information is available on by-catches of marine mammals in the Baltic.

History tells us that Baltic seals are very vulnerable to hunting especially during warmer periods with limited ice cover. The most important mechanisms here are that warm winters lead to lower intrinsic population growth rates both in ringed seals and grey seals, and that both species are more easily hunted since they occur in more concentrated groups at suitable habitats.

A re-colonization of former haul-out sites for grey (and harbour) seals south of 59º North is hampered by more frequent and intensified human activities along the coastline. It is therefore of outmost importance that potential haul-out sites become more strictly protected and regularly observed (Herrmann et al. in prep).

Predictions of future climate indicate that greenhouse gas emissions will lead to decreasing ice and snow coverage. Decreasing ice coverage and perhaps more importantly, decreased snow depth and a shorter ice covered season will have strong negative effects on the reproductive output of ringed seals especially in the Gulf of Finland, the Archipelago Sea and the Estonian coastal waters. Increasing frequencies of winters with no ice in these regions can lead to extirpation of the species in the south, and result in lowered reproductive output for ringed seals in the north, having to reproduce in suboptimal habitats. Harbour seals will be favoured by decreasing ice.

4.2.3 Conclusions

The conservation status of Baltic ringed seals is still unfavourable since the population growth rate over the past decade is close to zero in the Gulf of Finland and the Estonian coastal waters. The stock in the Bothnian Bay has been increasing by 4.3% per year since 1988, and this is less than half of the intrinsic capacity of increase. A future scenario with less ice and snow will not improve the situation for Baltic ringed seals. Management actions should therefore focus on reducing all kinds of mortality linked to human activities. Effects of decreasing ice coverage and shorter winters, in combination with the current low population growth rate in ringed seals, makes it unlikely that this species will reach a favourable conservation status by 2015. On the contrary, the three southern stocks in the Archipelago Sea, Estonia and the Gulf of Finland risk extirpation. Based on these factors the revised IUCN classification in 2008 will remain as "Vulnerable".

Harbour seals in the Kalmarsund are vulnerable because of their low numbers and limited genetic variation, but the population is expected to continue to grow. Current actions with conservation areas and banned hunting are sufficient to ensure future expansion of the population, but it will not reach favourable population status by 2015. Harbour seals in southern Baltic and the Kattegat-Skagerrak are expected to have favourable conservation status in 2015, but the current population is not expected to expand in the future since it is suggested to be close to the carrying capacity.

Although growing at a rate not far from the intrinsic rate of increase for the species (Harding et al. 2007) the Baltic grey seal is not established throughout its natural distribution, and cannot be classified to have a favourable conservation status according to this criterion. The Baltic grey seal is projected to expand in abundance, but the current growth rate is expected to be hampered in a scenario with warmer winters. An expansion of the population south of 59º North will require dedicated efforts in form of strictly protected areas designed for seals and a reduction of human impacts both landward and seaward of these sites.

4.2.4 Recommendations

Minimizing all human takes (hunting and by-catches) will improve the situation for Baltic ringed seals and harbour seals in the Kalmarsund. However, by-catches of all Baltic marine mammal species will remain substantial and exceed 2% of populations if the current structure of fisheries remains unchanged. The situation can be improved if fisheries with substantial by-catches change methods. This is the single most important factor affecting mortality rates in Baltic seals.

Decreasing nutritive status of ringed seals and grey seals suggest food resources might be limiting. Actions should be taken to manage fish stocks in accordance with the principles of the ecosystem approach.

Increasing prevalence of colonic ulcers is suggested to be caused by harmful chemical substances. Further actions should be taken to reduce dispersal of Xenibiotic organohalogen compounds affecting Baltic biota.

The pristine distribution of harbour seals and grey seals encompassed also the German, Polish and Kaliningrad coasts of the Baltic. Measures in form of protected areas and reduction of human impacts are required to ensure the main long-term objective "Natural Distribution" of the 2006 HELCOM seal recommendation.

4.2 TABLES

Table 4.2.1. General conservation issues for marine mammals in the Baltic.

	Population beginning 20th century	Estimated Hauled-out population/trend	International protection	Conflict seal/fishery	Major threats
Harbour seal	5 000 (Baltic Proper)	Baltic Proper: Currently: 630 1970s: 100 Trend +7.9% per yr	Bern/Bonn Conventions Habitats Directive	Minor	Contaminants/diseases Entanglement in fishing nets Human disturbances Food limitation
		Kattegat and S. Baltic: Currently:10 100 1976: 2 200 Trend:+3% per yr		Moderate	
Grey seal	90 000	North of latitude 590: Currently: 22 000 1970s: 2 500 Trend: +8.5% per yr	Bern Convention, Habitats Directive	Severe	Entanglement in fishing nets Contaminants/diseases Human disturbances
		South of latitude: 590 Currently: 640 Trend: slightly increasing			
Ringed seal	180 000	Gulf of Bothnia: Currently: 4 700 Trend: +4.3% per yr	Bern Convention	Increasing	Global warming Contaminants/diseases By-catches
		Bay of Riga: Currently:1 400 Trend: Zero		Minor	
		Gulf of Finland: Currently: 300 Trend: Zero Archipelago Sea: Currently:150		Minor	

4.2 FIGURES

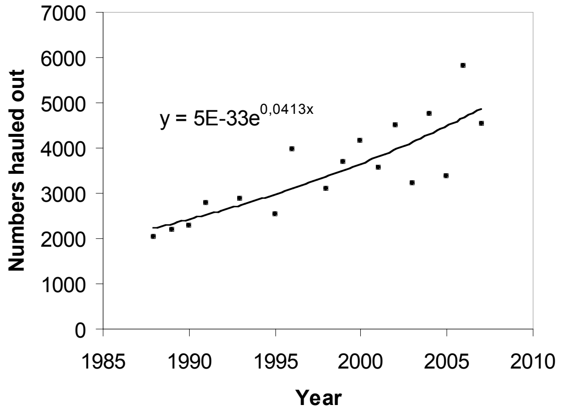


Figure 4.2.1. Numbers of ringed seals on ice in the Bothnian Bay 1988-2007. The mean annual rate of increase was 4.3% for the study period.

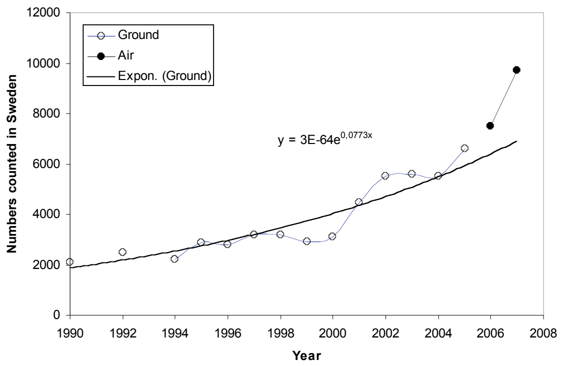


Figure 4.2.2. Numbers of grey seals counted from ground along the Swedish coast. The annual rate of increase was 8% up to 2005. Surveys from air started in 2006 give higher point estimates.

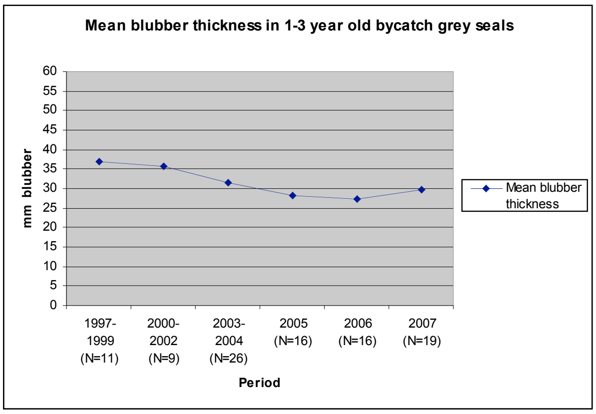


Figure 4.2.3. The mean blubber thickness in examined 1-3 years old by-caught grey seals from 1997 to 2007 in Sweden. Note: The decrease in mean blubber thickness between these years is significant (p<0.001). Usually the blubber layer in the Baltic grey seal is thicker in the second half of the year compared to the first half. In 1997-1999, 54% of the examined animals were found in fishing gear in the second half of the year

4.3 Birds

One of the great achievements of nature conservation in the 20th century was the establishment of protected areas all around the Baltic, including for the most important breeding and resting sites of sea birds. The unlimited persecution of species that for a long time had been considered as “harmful”, such as White-tailed Eagle and Great Cormorant, was stopped by nature conservation legislation. Finally, with the EU Bird Directive a comprehensive conservation regime for birds entered into force in 1979 and became effective for almost the entire Baltic, except of Russia, when Poland, Lithuania, Latvia, and Estonia joined the European Union in May 2004.

Despite these positive developments, anthropogenic factors such as pollution, habitat change or incidental killing still have a significant impact on bird populations in the Baltic Sea area.

There is no target of the biodiversity segment of the Baltic Sea Action Plan (BSAP) that addresses specific bird populations but there are several targets that embrace birds, primarily the target to reach *“By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species”*. This list currently includes 13 species of birds. Several targets of the biodiversity segment are also related to reducing the impacts of fisheries, an issue which is highly relevant for birds.

In addition, the Maritime Activity Segment of the BSAP includes the strategic goal *“To have maritime activities in the Baltic Sea carried out in an environmentally friendly way“*. Since maritime traffic is causing oil spills and release of hazardous substances and other wastes, this goal is also relevant for birds.

4.3.1 Status and trends

The following section gives descriptions of the status and population development of selected bird species. It aims to illustrate characteristic and representative developments.

Species which have indicative value for characteristic population developments of birds in the Baltic Sea region:

- Cormorant (*Phalacrocorax carbo sinensis*): Representative of species which have recovered after being nearly extinct by persecution, and which benefit from eutrophication;
- White-tailed Eagle (*Haliaeetus albicilla*): Representative of top-predators which have suffered by DDT and other chemical pollutants, and which have a positive population trend after the ban of these substances;
- Dunlin (*Calidris alpina*): Representative of waders, which are declining in many regions of the Baltic Sea;
- Barnacle Goose (*Branta leucopsis*): A new species which has occupied the Baltic Sea as a breeding area in recent time.

Typical marine and coastal species:

- Sandwich Tern (*Sterna sandvicensis*): A species which has expanded its range to the Baltic Sea during the 20th century; representative of the group of typical coastal birds;
- Eider (*Somateria mollissima*): A sea duck which has its main breeding sites at the coast.
- Razorbill (*Alca torda*): Representative of the auks; the Baltic Sea is breeding area of the species, but also wintering site for the birds from the northern Atlantic population.

Species of world-wide concern for which the Baltic is of special importance:

- Steller´s Eider (*Polysticta stelleri*): World-wide threatened species with globally important wintering populations in the Baltic Sea;
- Long-tailed Duck (*Clangula hyemalis)*: The species has been the most numerous bird wintering in the Baltic Sea, but is now most likely rapidly decreasing in numbers. It is heavily affected by chronic oiling.

Great Cormorant (*Phalacrocorax carbo sinensis*)

During the 19th century the Great Cormorant was exterminated as a breeder in several Baltic countries. The persecution continued during the 20th century, and in the early 1960s the European breeding population of the continental subspecies sinensis had declined to 4 000 breeding pairs (bp), of which Germany and Poland hosted more than the half.

The species was successful in re-colonising Denmark in 1938 and Sweden in 1948. As a result of protection measures, breeding pair numbers started to increase during the 1970s. By 1981, the numbers in the Baltic Sea area had reached approximately 6 500 bp, and in 1991 already about 51 000 bp.

Since about 1994, the population of the Great Cormorant has been fairly stable in the western part of the Baltic (Denmark and Germany, Figure 4.3.1), but breeding numbers have continued to increase in Poland (25 800 bp in 2006), Sweden (44 000 pairs in 2006), and the more recently colonised areas in the eastern Baltic.

The expansion to former breeding areas in the eastern Baltic took place during the 1980s and the 1990s. In Estonia, the Cormorant started to breed in 1983, in Lithuania in 1985, and in Finland in 1996 (Žydelis et al. 2002, SYKE 2007, V. Lilleleth, pers. comm.). In addition to the strong population growth in Finland and Estonia (Figure 4.3.2), numbers are also increasing in the Russian part of the Gulf of Finland (from 1 400 bp in 1994 to 3 800 in 2006), Lithuania (from 900 bp in 1995 to 3 700 in 2006), and in Kaliningrad (from 120 bp in 1991 to 8 500 in 2005). No increase has been recorded in Latvia where only 200-300 bp have been nesting since the mid-1990s.

The total of breeding pairs of Great Cormorants in the Baltic Sea riparian states amounted to about 157 000 bp in 410 colonies in 2006, with almost 80% of the birds breeding in Denmark, Germany, Poland and Sweden[2]. All large colonies in the Baltic Sea area are located near to the coast. The largest colonies are found around the highly eutrophic estuaries of the large rivers: Vistula Lagoon (11 500 bp in 2006 in a colony on Vistula Spit, Poland), Odra lagoon (10 750 bp in 2006 in five colonies in Mecklenburg-Western Pomerania and Poland), and Curonian Lagoon (11 300 bp in 2006 in two colonies on the Lithuanian and the Kaliningrad side of the lagoon).

Some Baltic countries have initiated management actions to control breeding numbers in order to reduce conflicts with fishery or to protect Salmon smolts. These actions include oiling or pricking of eggs in ground nesting colonies, scaring of birds attempting to found new colonies, and shooting of Cormorants around fish ponds, lakes or fishing devices. Illegal persecution is also reported from several countries.

Barnacle Goose (*Branta leucopsis*)

During the past decades the East Atlantic flyway population of Barnacle Geese, which consists of the Arctic Russian population, the temperate Baltic population and the temperate North Sea population, has increased in numbers from about 20 000 birds in 1959/1960 to about 550 000 birds in 2005/2006 (Ganter et al. 1999, Eichhorn et al. in prep., Figure 4.3.3). Birds of the Russian population, which is by far the largest one, are using the Baltic Sea coast as foraging sites during spring and autumn migration. Birds belonging to the recently established Baltic population breed mainly in colonies along the coasts of Gotland, Öland and Saaremaa in Sweden and Estonia, respectively, and in southern Finland (Larsson et al. 1988, Larsson & van der Jeugd 1998, Black et al. 2007, Mikkola-Roos et al. 2008). Smaller breeding colonies are also found in mainland Sweden, Denmark, and Germany.

The Baltic breeding population was naturally established in 1971 on Laus holmar off the eastern coast of Gotland. During the 1970s the colony increased in numbers and consisted in 1982 of 125 bp. In 1981, the first breeding pair was observed at the coast of Saaremaa, and in 1982 the first breeding was recorded on Öland. In 1989, the main colony on Gotland consisted of more than 1 000 pairs (Larsson & Forslund 1994). During the 1990s, the number of colonies increased considerably along the coasts of Gotland, Öland, Saaremaa and southern Finland. In 2002, about 5 300 pairs bred on more than 20 different small islands off Gotland and

2 Numbers include inland colonies; for Germany, only to the Baltic Federal States Mecklenburg-Western Pomerania and Schleswig Holstein are considered, for Russia St Petersburg and Kaliningrad regions.

Öland. Since then the overall number of breeding pairs has decreased due to the presence of red foxes on some of the breeding islands in some years (Figure 4.3.4). In addition to fox predation on nests and nesting adults, predation by White-tailed Eagle on nesting adults may affect the number of breeding pairs in some colonies. The total number of Barnacle Geese in the Baltic is currently estimated to about 25 000 individuals.

Reproduction success, measured as number of fledged young per pair, has been shown to be density-dependent and variable among years (Larsson & Forslund 1994). Large colonies may not produce more fledged young per year than small ones (Larsson & van der Jeugd 1998). The amount of high quality grass available for newly hatched chicks in May and June around the colonies, as well as predation by gulls, determine the production of fledged young. Annual survival rates of adults and fledged young are high (Larsson et al. 1998, van der Jeugd & Larsson 1998). Only limited hunting is permitted in the Baltic region.

Many, but not all, large colonies of Barnacle Geese on Gotland and Öland are situated within protected areas. The colonies in Finland, Estonia, mainland Sweden, Denmark and Germany range in size from a few pairs to several hundred pairs (Leito 1996, Mortensen & Hansen 1999, SOF 2006, Koop 1998, Mikkola-Roos et al. 2008). Some of the latter colonies are probably founded by birds of captive origin. However, birds from such colonies usually cannot be distinguished from other birds.

Eider (*Somateria mollissima*)

The main breeding areas of the Eider in the Baltic Sea are Sweden (270 000-360 000 breeding females, bf, in 1999/2000), Finland (80 000-100 000 bf in 2007), Denmark (25 000 bf 1990-2000), and Estonia (15,000 bf in 1995; BirdLife International 2004, Desholm et al. 2002, Hario & Rintala 2008). The species also occurs in small numbers in the Russian part of the Gulf of Finland (70-80 bf) and at the German Baltic coast (80-100 bf in 2008). In Poland, Lithuania, Latvia, and the Kaliningrad region of Russia the Eider does not, or only exceptionally, breed.

The Eider population has shown a strong long-term increase throughout the 20th century. Simultaneously, it has extended its breeding range southwards to the German Baltic coast, where the first breeding was recorded in 1985. However, since the late 1990s, stagnant or even strongly declining population trends are observed in several countries (Denmark, Sweden, Finland, Estonia; Desholm et al. 2002, Elts et al. 2008; Figure 4.3.5). In Finland, the Eider is currently the most rapidly declining sea bird species, dropping down from 150 000-180 000 bf in 2001 to only 80 000-100 000 in 2007 (Hario & Rintala 2008).

The decline is not only true for the Baltic breeding population, but for the Baltic/Wadden Sea flyway population as a whole. Mid-winter counts suggest that the total population could have fallen from 1.2 million birds in 1991 to 760 000 in 2000, which means a reduction of 36% (Desholm et al. 2002)[3]. Although reductions are evident for several breeding areas, the decline of the breeding population along the flyway seems to be less pronounced compared to the winter population. Shortcomings of the monitoring of breeding and wintering numbers, as well as an unknown buffering effect of non-breeders are probably the reasons for the difference (Desholm at al. 2002).

The recent population development maybe influenced by several factors, among them hunting, predation by Mink and White-tailed Eagle, bacterial and viral infections, parasite infestations, drowning in fishing gear, and oiling. Low reproduction success and high mortality of ducklins have been reported from several breeding areas in most recent year. However, several of these factors mentioned above have affected the population already in the past, when the number of Eiders in the Baltic was still increasing, and some impacts, such as hunting, used to be even higher than today.

The Eider is still being hunted in several Baltic countries, e.g. Denmark, Sweden, and Finland (see Hunting, Chapter 6). The presence of American Minks has caused substantial decreases of breeding bird numbers in

3 It has to be mentioned that these population numbers are probably underestimated, since they reflect the counted numbers without any attempt to correct for birds which have not been seen. Noer et al. (1995) estimated a population size of 1.5-2.0 mio birds in 1990. However, the estimated decrease of c. 30%, giving a total population of about 1.0-1.2 birds in 2000, seems to be realistic (Noer, pers. comm.).

those areas where it reaches high densities (e.g., Stockholm archipelago). Furthermore, the Mink forces the Eiders to change the nesting habitats, moving from bushy islets to gull colonies or solitary nesting gulls. In 1996 and 2001, outbreaks of Avian Cholera (caused by the bacteria *Pasteurella multocida*) have affected the population. In 1996 and 1999 in Finland, viral infections caused mass mortality among ducklings within the first weeks after hatch. Intestinal acanthocephalan parasite infestation is high among Eiders and may have an impact in association with other predisposing factors, such as impaired feeding ability or virus infections (Desholm et al. 2002). Drowning in stationary fishing gear is also an important mortality factor at least in some wintering areas (I.L.N. & IfAÖ 2005).

Steller's Eider (*Polysticta stelleri*)

Steller's Eider is one the rarest sea duck species, identified as "vulnerable" by the IUCN Red List of Threatened Species. The species nests in Arctic tundras with the bulk of the Western Palearctic population wintering along the Kola Peninsula and in Varangerfjord in the Barents Sea. A significant proportion of the regional population (10-20%) also regularly winters in the Baltic Sea.

Winter distribution in the Baltic is restricted to very few areas: around Saaremaa and Hiiumaa Islands in Estonia, Lithuanian coastal waters off Palanga, and Lågskär Archipelago in Finland. Sightings of Steller's Eiders are also regularly reported from Swedish and Latvian coastal waters.

Steller's Eiders were very rare in the Baltic Sea from the beginning of the 20th century until the early 1960s. Then, numbers of Steller's Eiders wintering in the Baltic increased steadily until the mid 1990s (Nygård et al. 1995). This period was followed by a rapid decline of bird abundance across all wintering sites (Žydelis et al. 2006). Peak numbers reaching 5 000 wintering individuals in Estonia and 2 000 in Lithuania dropped to lows of 1 500 and 90, respectively. Numbers of migrating birds counted in Finland, in general also followed the same declining trend (Lehikoinen 2007). Numbers of wintering bird in Estonia, however, showed signs of increase during the most recent winters (Figure 4.3.6).

The reasons for the recent decline of Steller's Eider Baltic wintering population are not clear. Most likely, a combination of different factors is in play, including shift to wintering sites outside the Baltic, decreased reproductive success, and threats affecting bird survival.

Conservation concerns for Steller's Eider in the Baltic Sea include accidental bird mortality in fishing nets, the threat of oil pollution and the possibility of habitat degradation. The species is extremely site-faithful and regularly occurs on very few sites. Therefore, Steller's Eiders are highly sensitive to factors affecting their wintering habitats.

Long-tailed Duck (*Clangula hyemalis)*

The Baltic Sea is a globally important wintering area for the Long-tailed Duck. Surveys in 1992 and 1993 showed that approximately 4.3 million birds from the Fenno-Scandinavian and Russian breeding populations were wintering on offshore banks or in coastal areas of the Baltic Sea. About 66% of the wintering birds were found at four geographically limited offshore areas: Hoburgs Bank south of Gotland, Irbe Strait, Gulf of Riga, and Pomeranian Bay (Durinck et al. 1994). Although no surveys with complete coverage have been performed since then, spring migration counts in Finland and Estonia as well as regional winter surveys indicate that the total wintering population of Long-tailed Ducks has decreased dramatically in numbers in recent years (Kauppinen 2008, Nilsson & Green 2007, Bellebaum pers. comm.).

Since the majority of the birds are wintering on a few offshore sites the population may be severely affected by oil spills from ships, fishery by-catch, and habitat changes. An important shipping route from the southern Baltic Sea to the Gulf of Finland with approximately 22 000 ship passages per year passes through the "Natura 2000" site Hoburgs Bank. A large number of smaller oils spills, most of them less than 1 tonne, are registered along the route each year. Weekly winter surveys of oiled birds at southern Gotland between 1996/97 and 2006/07 have shown that several tens of thousands of Long-tailed Ducks are annually killed by oil in the central Baltic Sea (Larsson & Tydén 2005, Larsson 2007). Furthermore, analyses of 998 Long-tailed Ducks drowned in fishing gear at Hoburgs bank showed that a large proportion, about 12% of the birds, had oil in the plumage (Larsson & Tydén 2005). Although any kind of oil discharge from ships is strictly prohibited in the Baltic Sea, chronic oiling is most likely an important reason for the decline of the European wintering population of the Long-tailed Duck.

White-tailed eagle (*Haliaeetus albicilla*)

The White-tailed Eagle breeds in coastal and inland lake areas of all Baltic countries. These countries, together with Norway, host the major part of the European population, which nowadays probably accounts for more than 50% of the global population.

Though the White-tailed Eagle is not a "true" coastal species, it reaches remarkably high concentrations in some coastal areas. The Odra lagoon area, for instance, has been known as one of the last density centres during the first half of the 20th century (Mizera 2002), and today still shows the highest density of breeding pairs in Central Europe (Hauff et al. 2007). In Lithuania, a concentration of breeding sites in the Nemunas delta and around the Curonian Lagoon is obvious (Dementavičius 2007). Also in Sweden, the major part of the population is found along the coast (Tjernberg & Svensson 2007). In Finland, the species is concentrated on the south-western coastal areas, but also occurs along the whole coastline and around large inland lakes in Lapland.

At the beginning of the 20th century, as a consequence of severe persecution the White-tailed Eagle was close to extinction all around the Baltic Sea. In Denmark, the species even disappeared after 1911; in Mecklenburg-Western Pomerania, in 1913 only 23 bp were known, and the Polish population of that time is estimated at about 20 bp (Hauff & Wölfel 2002, Mizera 1999). Also in Lithuania and the Kaliningrad region of Russia the White-tailed Eagle disappeared for a long time.

Due to protection measures against persecution, the population started to recover during the 1920s, but the positive trend was reversed from the mid-1950s to the early 1980s by the harmful effects of chemical pollutants (DDT and PCBs) on fertility and reproduction success. The proportion of successful breeding pairs dropped down to only 20-30%, and the reproduction success to 0.2-0.4 fledglings per breeding pair. As a consequence, the population remained stagnant or even decreased. Owing to the ban of DDT and other pesticides in the early 1970s, the reproduction parameters started to improve at the beginning of the 1980s, and returned to normal levels in the mid-1990s (Figure 4.3.7).

Currently, the White-tailed Eagle is increasing in all Baltic countries (Table 4.3.1, Figure 4.3.8). Simultaneously, the species returned to territories abandoned in the past (e.g. Lithuania 1987, Denmark 1995). In recent years, a range expansion to the west (western and south-western parts of Germany) has been observed, and in 2006 the first breeding pair was recorded in the Netherlands.

Dunlin (*Calidris alpina schinzii*)

The southern sub-species of the Dunlin, *Calidris alpina schinzii*, colonises south-eastern Greenland, Iceland, the Faeroe islands, Great Britain and Ireland, southern Norway, and the Baltic Sea. In the southern North Sea (Belgium, Netherlands and Germany), the Dunlin has been a breeding bird in the past, but in recent times breeding records are few and irregular.

At the beginning of the 20th century, the Dunlin was still a very common bird around the Baltic. The Danish breeding population at that time is estimated at 50 000-100 000 bp (Thorup 1997), and also in Sweden, Germany, Poland and Estonia the species was widespread and common. Since then the Baltic Dunlin suffered a continuous, dramatic decline: The Danish population declined to about 600 bp in 1970 (Ferdinand 1980), 450 bp at the mid-1990s (Grell 1998), and 350 bp in 2002 (Thorup 2003). The breeding pair numbers in Sweden and Estonia declined to currently around 100 and 200-250 bp, respectively. Along the southern and eastern coasts of the Baltic Sea (Germany, Poland, Lithuania, Latvia, Kaliningrad and St Petersburg regions of Russia) the Dunlin has already disappeared or is close to extinction (Table 4.3.2). In Finland, the Southern Dunlin has never been numerous. During the last years (2003-2007) the number of breeding pairs was between 50 and 60. The total Baltic population was estimated at about 1 110-1 360 bp in 2002 (Thorup 2006), and not more than 700-800 bp in 2007 (Table 4.3.2).

Habitat loss by drainage and land reclamation have been considered as reasons for the population decline in the past. An increase of predators and management problems for coastal meadows seem to be other important factors affecting the population. However, the dramatic long-term decline from probably far more than 100 000 bp at the beginning of the 20th century to less than 1 000 one hundred years later cannot be explained just by habitat loss and predation. Even in those areas where suitable habitats have been conserved and properly managed, the Dunlin is declining or even has disappeared. In Germany, Denmark, Sweden and Lithuania, restoration projects for breeding habitats of Dunlin, Ruff and other waders have been implemented recently or are under implementation. Also in Finland and Poland specific programmes and projects aiming to restore breeding habitats are being implemented. However, these efforts do not yet show positive effects for the Dunlin population. It is very likely that the rapid decline of the Dunlin in the Baltic Sea area is not a consequence of habitat loss, but rather driven by large-scale factors such as climate change.

Sandwich Tern (*Sterna sandvicensis*)

At the beginning of the 20th century, the Baltic Sea was still not part of the breeding range of the Sandwich Tern. However, during the first half of the century the species expanded its range gradually to the north-east, colonising Skåne in 1911, and the Swedish east coast during the 1930s. Starting with the formation of a colony on the island Heuwiese (Germany, Mecklenburg-Western Pomerania) in 1957, the Sandwich Tern continued its range expansion to the southern coasts of the western and central Baltic, becoming a permanent breeding bird first at the German Baltic coast and short time later, in 1962, in Estonia. In Poland it bred from 1977-1991 and again since 2006.

The range expansion and positive population development in the Baltic during the 1950s/1960s happened at a time, when the North Sea population declined dramatically. This indicates that the colonisation of the Baltic Sea could have been a response to the worsening of the environmental conditions in the North Sea.

The Baltic breeding population grew constantly and reached about 2 500 bp by the end of the 1970s. Since then, despite some fluctuations and frequent shifts of breeding sites, it can be considered as more or less stable. More detailed surveillance data from the mid-1990s until now reveal a population size fluctuating between 2 000-3 500 bp (Figure 4.3.9).

The main conservation measure for the Sandwich Tern is the protection of suitable breeding sites. These are especially breeding colonies of Black-headed Gulls on small islands covered by low grass vegetation, without human disturbances or presence of predatory mammals.

Razorbill (*Alca torda*)

The Razorbill is a widespread breeder in coastal areas of north-west Europe. Its European breeding population is large (430 000-770 000 bp, BirdLife International 2004), with Iceland hosting more than 50% of it. In the Baltic Sea area, the Razorbill breeds in Sweden (9 000-11 000 bp in 1999-2000), Finland (6 000-8 000 bp in 1998-2002), Russia (St. Petersburg Region, 150 bp), Denmark (max. 965 bp in 2006), and recently also with a few (1-10) pairs in Estonia. The Baltic population has been increasing during the 1990s (Birdlife International 2004, Elts et al. 2003).

The only Danish breeding colonies are found on Bornholm and Græsholm (a small rocky island of the Ertholmene archipelago east of Bornholm). This site was colonised by the species during the 1920s. From 1983-2000, the population increased from about 280 bp to 745 (Lyngs 2001), and reached 965 bp in 2006 (Christiansø Feltstation).

Ringing recoveries show, that Razorbills from the Baltic breeding population usually stay all year round in the Baltic Sea. For instance, out of 269 ringing recoveries of birds ringed in Denmark (Græsholm and Bornholm), 265 were derived from the Baltic Sea and Kattegat, 3 from the Skagerrak, and only one from the North Sea, close to the entrance of the Skagerrak (Bonlokke et al. 2006).

Most birds of the Baltic breeding population winter in the central part of the Baltic Sea, including Irbe Strait and the Gulf of Riga (Durinck et al. 1994). However, ringing recoveries of Razorbills from Bornholm/Ertholmene show that the inner Danish waters are also used as wintering site (Bonlokke et al. 2006).

Razorbills of the North Atlantic breeding population are wintering in high numbers in the central and northern Kattegat. Danish ringing recoveries give evidence that outside the breeding season birds from the British Isles (mainly Scotland), Norway, and Russia are visiting the Kattegat and inner Danish waters (Bonlokke et al. 2006). The number of birds wintering in this area shows strong fluctuations. From 1988-1993, on average 13% of the North Atlantic population were wintering here, but in some years the numbers are even much higher (Durinck et al. 1994).

Ringing recovery data as well as by-catch studies show that gillnet fishery is an important mortality factor for the species (Hario 1998, I.L.N. & IfAÖ 2005).

4.3.2 Conclusions

Long-term data about the population development of bird species of the Baltic Sea show that a more or less stable "status quo" neither exists nor ever existed. Dynamic changes in terms of range and size of populations are characteristic. Some of the observed long-term changes clearly can be attributed to persecution or impacts on the reproductive success caused by hazardous substances. Other anthropogenic factors, such as loss of habitats, introduction of non-native predatory mammals, oil spills and by-catch in fishing gear, also may affect bird populations. On the other hand, human land use management also may promote certain species: due to the high nutrient inflow from the catchment area, biomass production is enhanced in the Baltic, improving the feeding conditions for some species (e.g. Cormorant). Last but not least even fishery practices may have promotional effects for birds: the good status of auks is, at least partly, attributed to the growth of the sprat stocks due to overfishing of cod.

However, not all population developments of bird species in the Baltic Sea can solely be attributed to anthropogenic factors. The decline of Dunlin and Ruff, the fluctuations of wintering populations of Steller's Eider, or the range expansion into the Baltic of Sandwich Tern, Herring Gull and Barnacle Goose are examples of population developments which are obviously not, or at least not in the first line, driven by human activities. Global factors such as climate change or environmental changes in breeding areas outside the Baltic Sea certainly also exert a strong impact on range and population size of bird species.

Strategic approaches for the conservation of birds in the Baltic Sea have to acknowledge the dynamics of their populations with respect to range and size. They should focus on anthropogenic factors which are known to have adverse impacts on bird populations or which have to be considered as potential threats. It must be recognised that the decline of some species (e.g., Dunlin, Ruff in the southern and western Baltic) has to be attributed to other reasons than direct anthropogenic impacts such as habitat destruction or contamination. It will probably not be possible to reverse the negative population trend of these species by nature conservation measures.

4.3.3 Recommendations

Conservation measures should focus on those species which are negatively affected by anthropogenic factors such as habitat loss, deliberate or incidental killing, or hazardous substances.

In order to reach a "favourable conservation status of Baltic Sea biodiversity" the protection of important bird habitats, including breeding, resting and wintering sites, is necessary. The establishment of an ecologically coherent network of Baltic Sea Protected Areas (BSPA), Natura 2000 areas and Emerald sites in the Baltic Sea by 2010 is an important step towards the protection of these sites.

Restoration and adequate management of degraded areas, especially coastal meadows and wetlands, are also important measures to improve habitat conditions for birds.

The BSAP target *"By 2012 spatial/temporal and permanent closures of fisheries of sufficient size/duration are established thorough the Baltic Sea area"* should consider the high conflict of gillnet fishery in wintering areas of sea birds; seasonal closures of gillnet fisheries in areas with high sea bird concentration are required to achieve the target *"by-catch rates of water birds close to zero by 2015"*.

The strategic goal of the BSAP to have *"maritime activities in the Baltic Sea carried out in an environmentally friendly way"* requires actions to reduce bird mortality related to illegal or accidental discharches of oil, hazardous substances and other wastes. In order to reduce killing of birds by oil spills, routing of ships has to be improved, i.e. major resting and wintering sites of sea birds should be declared by IMO as "areas to be avoided".

Conflicts between birds and offshore installations (e.g. wind parks) should be minimised by adequate spatial planning. Furthermore, more research is needed in order to improve the knowledge about bird behaviour on sea and possible interactions between birds and offshore installations.

The assessment of the conservation status and population development of birds in the Baltic Sea area needs continuous monitoring of: i) range and size of breeding populations of bird species, ii) distribution and numbers of wintering populations of birds, iii) conservation and management status of breeding sites and areas, iv) monitoring of anthropogenic mortality (hunting, oil spills, fishery by-catch, and vi) monitoring of reproductive parameters of indicator species for the impact of hazardous substances.

Many of the required monitoring data are already collected in the Baltic countries. However, a regular Baltic-wide compilation and assessment of the data is not yet organized. Therefore, it is recommended to design and implement a "HELCOM Baltic bird monitoring programme".

4.3 TABLES

Table 4.3.1. Development of the population of White-tailed Eagle in the Baltic Sea riparian states.

Country	Territorial pairs			Current population trend
	1991	1998	2007	
Denmark	0	5	17	++
Estonia	40	60	150-170	++
Finland	78	151	271	++
Germany - SH	8	20	53	++
Germany - MV	102	153	242	++
Latvia	5-8	11	25	++
Lithuania	7	25-30	90	++
Poland	300	500	700-800	++
Russia, Kaliningrad region	1-4	5-6	>20	++
Russia, St Petersburg region	15	20	25-30	+
Sweden	106	219	500	++
Baltic Sea riparian states	660- 670	1 170-1 180	2 100-2 250	??

Table 4.3.2. The Dunlin population in the Baltic riparian states.

Country	Current breeding population	Remarks	Source of information
Denmark	350	numbers 2002	Thorup (2003)
Sweden	85-120	numbers 2006	M. Larsson, pers. com.
Estonia	200-250	numbers 2007	Elts et al. (2008)
Finland	50-60	2003-2007	Finnish working group of Southern Dunlin, Ministry of Environment Finland
Germany, Mecklenburg-Western Pomerania	9	numbers 2007	Working Group for Coastal Bird Protection Meckl.- W. Pomerania
Germany, Schleswig-Holstein	0	at the west coast (North Sea) probably still 0-5 bp	Knief, pers. comm.
Latvia	1-5	1989-1997	Thorup (2006)
Lithuania	25-30	1996-1998	Thorup (2006)
Poland	0-5	no breeding record in 2007, but the observation of some individuals during the breeding season suggests that breeding of a few pairs is still possible	Sikora et al. (2008)
Russia – St. Petersburg Region	1-5	sporadic breeder at the Gulf of Finland, one nest found in 2008	Fedorov, pers. comm.
Russia –Kaliningrad Region	2	2001, no breeding record after 2001	Grishanov & Lykov 2008
Baltic Sea riparian states	700-800		

4.3 FIGURES

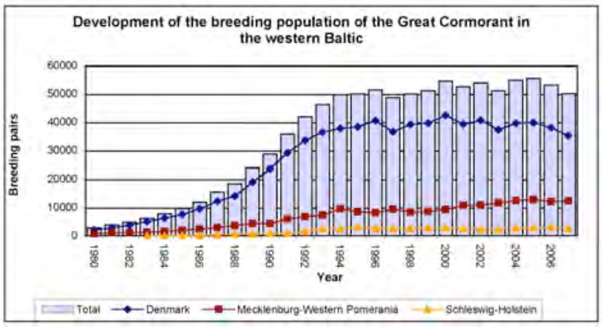


Figure 4.3.1. The population of the Great Cormorant in the western Baltic (Denmark and northern areas of Germany) is about stable since the mid-1990s.

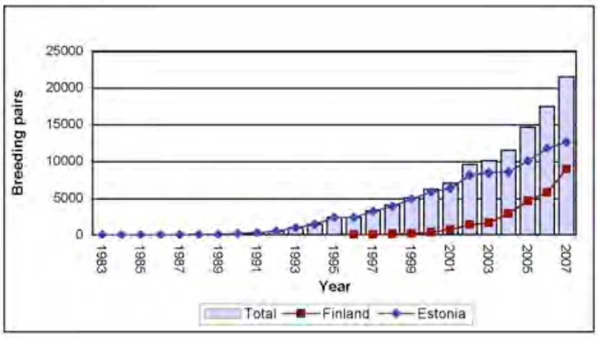


Figure 4.3.2. In the eastern Baltic, the Cormorant population is still increasing (the total is the sum of Finland and Estonia). Data from SYKE 2008 and V. Lilleleth, pers. comm.

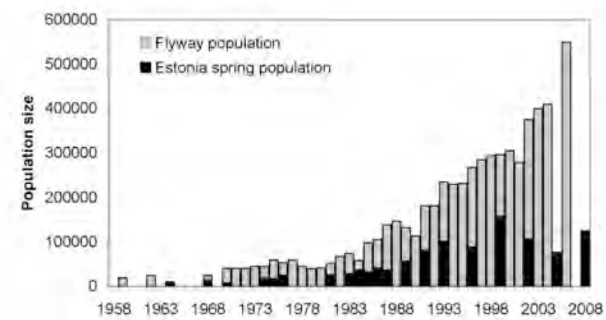


Figure 4.3.3. Development of the flyway population and Estonian spring population of Barnacle Goose 1959-2008 (Eichhorn et al., in press).

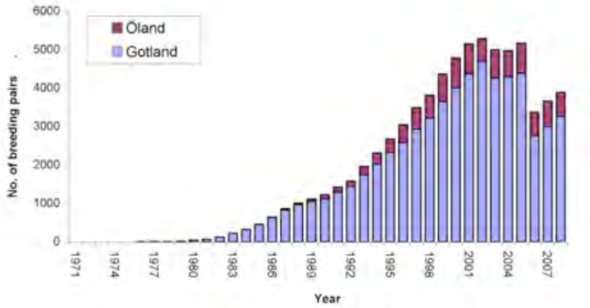


Figure 4.3.4. Number of breeding pairs of Barnacle Geese in the main Baltic colonies on Gotland and Öland, Sweden. The first breeding pair in the Baltic Sea was recorded in 1971. Reductions of the number of breeding pairs in 2003 and 2006 are due to the presence of foxes on major breeding islands.

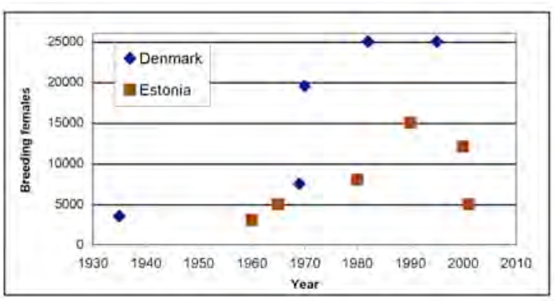


Figure 4.3.5. The Development of the Eider population in Denmark and Estonia during the 20th century. Data from Desholm et al. (2002), Lyngs (2000 and unpublished), and Elts et al. (2008).

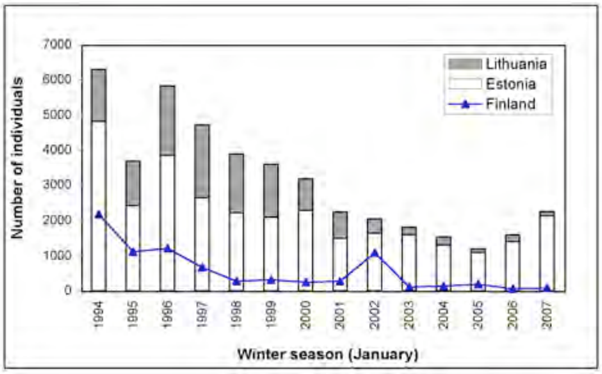


Figure 4.3.6. Numbers of wintering Steller's Eiders in Estonia and Lithuania, and migrating birds at Hanko-Helsinki, Finland.

Figure 4.3.7. The development of reproduction parameters of the White-tailed Eagle in Mecklenburg-Western Pomerania 1973-2007.

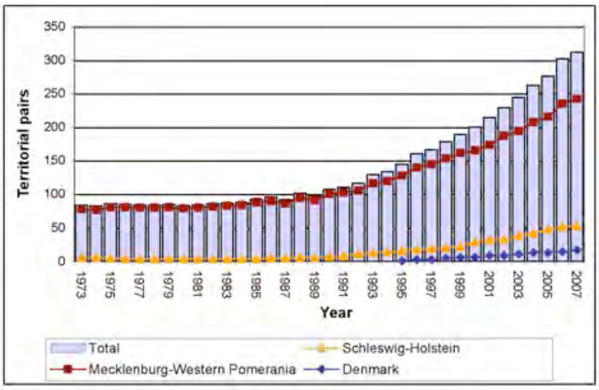


Figure 4.3.8. The population development of the White-tailed Eagle in the western Baltic (Denmark, Schleswig-Holstein, and Mecklenburg-Western Pomerania) 1973-2007.

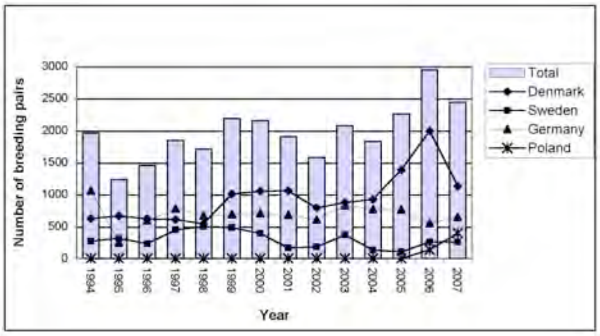


Figure 4.3.9. The breeding population of the Sandwich Tern in Denmark[4], Sweden[5], Germany, and Poland 1994-2007. For the Estonian population, detailed data are not available; it is estimated to amount about 600-900 bp (Herrmann et al. 2008).

4 Only Baltic breeding sites, i.e. colonies of the central and southern Kattegat, Belt Sea and the Sound are considered, but not the breeding population of the northern Kattegat and the North Sea

5 The surveillance of the Sandwich Tern in Sweden was not complete in all years.

4. BOXES

Box 4.1 Threatened and/or declining species in the Baltic Sea

The Baltic Sea is a unique marine ecosystem – a home for both marine and freshwater species, adapted to the brackish-water conditions. After decades of continuing human pressure, many of the species have been pushed to their tolerance limits, resulting in population declines, severe population crashes and even a case of extinction. The Baltic Sea Action Plan (BSAP) sets the goal to achieve “Thriving and balanced communities of plants and animals” as well as “Viable populations of species”. With this as a background, HELCOMs work for endangered or threatened species is of high priority to fulfil the biodiversity segment of BSAP. To reach the goal HELCOM has made first steps to identify the threatened species and species which are threatened or show a declining population trend due to direct or indirect various human pressures.

The HELCOM lists of threatened and/or declining species and biotopes/habitats in the Baltic Sea area were adopted in 2008 (HELCOM 2008). The species list concentrates on species which have a clear relation to the Baltic Sea marine environment and therefore does not include freshwater species. Even with these limitations, the list grew alarmingly long: 14 plants species, seven species of invertebrates, 13 bird species, 23 fish species and four mammal species. Due to varying environmental conditions in different parts of the Baltic Sea area, the HELCOM list of threatened and/or declining species specifies the distribution and threat status for all 18 sub-regions (HELCOM 2008). The aim of the list is to report on species which are in urgent need of protective measures.

According to the BSAP, a more comprehensive red list of Baltic Sea species must be produced by 2013. A comprehensive red list of threatened and declining species of lampreys and fish of the Baltic Sea already exists. It includes altogether 184 fish species from 15 monitoring areas. Based on abundance data and known pressures on the species, the fish assessment considered 34 species (18.5%) to be of high priority for conservation (HELCOM 2007). However, many of the high priority species are still inadequately protected or monitored, even within marine protected areas. This first Baltic Sea wide red list for a species group will be updated by 2013. Even before that, by 2011, the conservation status of non-commercial fish species will be assessed. Since coastal fish, in particular, have a structuring role in coastal food webs, the BSAP recommends countries to protect, monitor and sustainably manage these species and to develop by 2012 region-specific reference values in order to assess the status of the populations in future.

HELCOM (2007) HELCOM Red list of threatened and declining species of lampreys and fish of the Baltic Sea. Baltin Sea Environmental Proceedings, No. 109, 40 pp. Available at: http://www.helcom.fi/stc/files/Publications/Proceedings/bsep109.pdf

HELCOM (2008) HELCOM lists of threatened and/or declining species and habitats/biotopes in the Baltic Sea area. Baltic Sea Environmental Proceedings, No. 109, 40 pp. Available at: http://www.helcom.fi/stc/files/Publications/Proceedings/bsep113.pdf

CHAPTER 5: TOWARDS INDICATOR-BASED ASSESSMENT OF THE BALTIC SEA BIODIVERSITY

This chapter tests the applicability of an explicit indicator –based approach to assessing Baltic marine biodiversity based on a set of national case studies. The HELCOM Monitoring and Assessment Strategy[6]) has a distinct focus on indicators, compiled in regular thematic assessments (like this one on biodiversity) and eventually in overall regional holistic assessments covering the whole Baltic Sea. The aim is to make assessments more condensed in terms of text, presenting instead numerically the contrast between a desired, or historically observed, situation and the present status for the selected indicators. This approach has the advantage that it allows (at least in principle) a more transparent way of defining the exact content of verbal statements like "favourable status", as well as allowing more straightforward monitoring whether environmental and nature protection commitments have been met.

However, it is also clear that compared to issues like eutrophication, biodiversity is a very challenging field for implementing such an indicator approach. This is partly due to the wide range of issues covered by the term "biodiversity", less work done in producing indicators for the covered issues, as well as certain gaps in the information required-especially in terms of desired/target level of indicators. This chapter uses a set of national case studies and an overall assessment of the Baltic Proper sub-basin to a initiate discussion on the approach for future HELCOM Biodiversity assessments.

5.1 Data & Indicator availability

Twenty-two national case studies from eight countries were submitted for testing an indicator based Baltic marine biodiversity assessment. The location of the study sites is shown in Figure 5.1. Table 5.1 lists the study sites and data sources (available as HELCOM BIO and HELCOM EUTRO PRO meeting documents). A compilation of available indicators for the Baltic proper is assessed separately in order to test a geographically more wide, sub-basin approach.

5.2 Assessing indicator status

The assessment approach used needs three key steps to be applied for each assessed indicator and site: (1) defining reference conditions reflecting a pristine status, (2) definition of an acceptable deviation from reference conditions defining the limit of "good status", and (3) using information on present status in calculating whether the present situation is equivalent to "good status". If pristine status can not be defined a tentative target value, combining steps 1 and 2 can be specified and revised according to the adaptive management approach.

For the national case studies the level of acceptable deviation from reference condition/state have been chosen freely, according to best available information, by authors of the national case studies. However, the highest possible value of the acceptable deviation was fixed to 50%, a value which was used also if no other acceptable deviation has been specified. The following five quality classes are used: high, good, moderate, poor and bad, where '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). The technical details of the used assessment approach can be found in Box 5.1.

5.3 Combining indicators for overall assessment: BEAT Matrix

In order to create an overall assessment of the site the indicators available were grouped in the following four categories: Category I - Landscapes, Category II – Communities, and Category III - Species, following the

6 adopted by HELCOM 26/2005 (paragraph 3.17 (LD 16) of the Minutes of HELCOM 26

structure agreed with the HELCOM Baltic Sea Action Plan. In addition to these three categories an additional category IV for supportive features has been included to cover other parameters of interest. The topics covered under each of these categories is presented in Table 5.2[7]. Within the categories I-IV, a weighted average of the ratios between pristine and present status (i.e. EQRs), as well as that of the acceptable deviations of the individual indicators was calculated. On the basis of these values the categories I-IV were given a quantitative assessment (ranging from high to bad) on the same lines as a single indicator described above.

The overall assessment of the site (combined result of the four categories) is made by applying the so-called 'one out, all out' principle to the categories I-III. This implies that the worst performing category defines the overall status. The category IV is an exception as it is a supporting category, not to be used in the overall assessment of biodiversity status.

5.4 Results

19 of the 22 national case study areas are classified overall as either having a 'moderate', 'poor', or 'bad' biodiversity status meaning that these areas are in an unfavourable condition in terms of the indicators reported (Table 5.3). The only exceptions are case studies 1, 3 and 4, which do not cover other issues than coastal fish and supporting features. See [reference to a separate background document] for complete assessment sheets, including more information on the indicators used at each site.

A Baltic Proper sub-basin test assessment is presented as Table 5.4. As very few biodiversity topics have so far been considered using an indicator approach, it is natural that in such a sub-basin approach the indicator selection is heavily dominated by few well studied topics, e.g. zoobenthos.

5.5 Discussion & challenges for a future indicator-based assessment

The 2007 HELCOM Baltic Sea Action Plan identified the need for continuous monitoring of the conservation status of biodiversity and the need for regular assessments on the issue using a harmonized, indicator-based approach. This chapter has tested indicator-based biodiversity assessment by applying the HELCOM biodiversity assessment tool (BEAT) in a number of national case studies as well as sub-regionally in the Baltic Proper basin.

A majority of the case studies imply an unfavourable conservation status in the assessed areas. The few areas where a favourable conservation status was reported were mainly from areas where only one component of the marine biodiversity (e.g. fish) had been reported. The most commonly used indicators in the national case studies were those monitored for eutrophication assessment purposes, e.g. distribution of submerged aquatic vegetation and benthic fauna indices. Even if these are often relevant indicators of also biodiversity, and even nature conservation issues, it is clear that e.g. area based, and species specific, indicators were few (Table 5.3).

In most parts of the Baltic Sea many of the components commonly associated with marine biodiversity (e.g. hard bottom community structure, porpoises, birds) have not been covered by operational monitoring systems for a very long time, if at all. There are also significant problems in assigning the reference conditions required by the used approach for many of these issues, mainly due to high natural variability, provoking a healthy skepticism by the HELCOM scientific contacts. Nevertheless the received 22 national reports witness a relatively open attitude towards such an indictor based assessment approach. Interestingly, not a single Marine Protected Area (MPA) was among the reported test areas even if it would be reasonable to assume that they should be monitored relatively intensively over a wide range of biodiversity topics.

Overall, it is clear that for several of the issues discussed in this assessment, indicators still need to be developed and most importantly reference conditions have to be set. The themes for these future biodiversity indicators are likely to be found in the different chapters of this assessment and will be developed further in HELCOM

7 Note that in order to follow a harmonised approach the indicators provided in the national case studies have been regrouped accordingly.

groups. The sub-regional approach illustrated with the Baltic Proper case study (Table 5.4), should in the future be utilized fully using agreed basin divisions e.g. areas indicated with lines in Figure 5.1.

For future implementation of this approach the reasoning behind defining acceptable deviations, and the reference value, should be documented better. This is necessary in order to take into account the range of natural variation and threshold values that are linked to risk of population collapse and regime shifts. Further, the possibility to rate the confidence to the reference, present and acceptable deviation values of a given indicator is one important aspect for future consideration. This option, used in the HELCOM Eutrophication Assessment Tool (HEAT, see HELCOM 2009), was not available during the time the presented national case studies were collected but would likely increase the overall confidence to the results of an indicator-based assessment.

5. TABLES

Table 5.1. Overview of national case study sites with a reference to source.

Number	Country	Name	Description	Data source
1	Sweden	Kvädöfjärden (inner)	Rocky archipelago area ca. 25 km^2	Olsson et.al. 2008
2	Sweden	Askö-Landsort area	400 km^2 area, University research station	Blomqvist, 2007
3	Sweden	Forsmark (inner)	32 km^2 of relatively unexploited coastline	Olsson et al. 2008
4	Sweden	Holmöarna	Ca 15 km^2 archipelago area	Olsson et al. 2008
5	Finland	Finbo	Archipelago area in Åland	Ådjers & Lappalainen 2008
6	Finland	Archipelago Sea (inner)	Area close to the Finnish mainland	Ekebom et al., 2007
7	Russia	Neva Bay (outer)	Russian waters off the St.Petersburg barrier	Golubkov, 2007
8	Russia	Neva Bay (inner)	400 km^2 area inside the St. Petersburg barrier	Golubkov, 2007
9	Estonia	Pärnu Bay	Ca. 700 km^2 bay with strong riverine input	Ojaveer & Martin, 2007
10	Estonia	Gulf of Riga, northern parts	Ca 8000 km^2 area of open and coastal waters	Ojaveer & Martin, 2007
11	Latvia	Gulf of Riga, southern open	Single Latvian offshore monitoring station	Ikauniece et al., 2007
12	Lithuania	Curonian lagoon	Lagoon	(national EUTRO-PRO)
13	Poland	Puck Bay	360 km^2 inner part of Bay of Gdansk	Andrulewicz & Weslawski 2008
14	Germany	Fehmarn Belt	69 km^2 area surrounding Fehmarn island	Karez et al 2008
15	Germany	Neustadt Bay	46 km^2 area, inner parts of Lübeck Bight	Karez et al 2008
16	Germany	Bülk (outer Kiel Fjord)	15 km^2 area outside Kiel Fjord	Karez et al 2008
17	Germany	Gelting bight	44 km^2 area of relatively exposed coastline	Karez et al 2008
18	Denmark	Odense Fjord	62 km^2 shallow, eutrophic estuary	HELCOM, 2006
19	Denmark	Limfjorden	1468 km^2 long semi-enclosed waterbody	Andersen & Kaas, 2008
20	Denmark	Randers Fjord	27 km long, shallow estuary	HELCOM, 2006
21	Denmark	Isefjorden-Roskilde fjord	Two connected fjords	(national EUTRO PRO)
22	Denmark	The Sound	118 km strait with a distinct halocline	Henriksen et al., 2008

Table 5.2. Grouping of indicators to categories

Categories (Ecological Objectives on biodiversity and supporting features)	Indicators included within category
Category I: Marine Landscapes	Area based indicators (all types)
Category II: Communities	Community Indicators on Phytoplankton,Zooplankton, Zoobenthos, Macrophytes, Fish community, Bird community, Endangered habitats and biotopes
Category III: Species	Single species indicators of high profile species mainly fish, birds and mammals as well as indicators on endangered and alien species
Category IV: Supporting features	Indicators of environmental parameters including e.g. Water clarity, Water temperature, Oxygen concentrations, Nutrients

Table 5.3. Assessment results of the national case studies expressed as EQR values and quality classes. Note that category classification depends on weighted acceptable deviation of indicators, not only raw EQR value shown. The overall status is based on the used of the ’one out, all out’-principle i.e. the worst performing category. Key: ML = marine landscapes, CO = communities, SP = species, and SF = ’supporting features’, F=Fish, Z=Zoobenthos, M=Macrophytes, P=Phytoplankton, Zp=Zooplankton,B=Birds, S=Seals, E=Endangered species, C=water Clarity, T=water Temperature, N=Nutrients O=Oxygen, S=Salinity.

Case study areas	Topics covered within category				Ecological Quality Ratio				Ass.
	ML	CO	SP	SF	ML	CO	SP	SF	
1. Kvädöfjärden	-	F(4)	F(2)	C(1), T(1)	-	High	High	Mod.	High
2. Askö-Landsort	-	Z (1), M (1), P (2)	-	C(1), N(6)	-	Mod.	-	Bad	Bad
3I. Forsmark (inner)	-	F(4)	F(2)	T(1), C(1)	-	High	High	High	High
4. Holmön inner	-	F(4)	F(2)	T(1), C(1)	-	High	Good	High	Good
5. Archipel. S.	1	B(1), Z (2), P(2)	-	C(2)	Bad	Mod.	-	Mod.	Bad
6I. Finbo	-	F(3)	F(3)	T(1),C(1),S(1)	-	Mod.	High	High	Mod.
7I. Neva Bay (outer)	-	Z(2), F(1)	S(1),E(2)	-	-	Bad	Bad	-	Bad
8. Neva Bay (inner)	2	Z(3), F(1)	-	-	Mod.	Poor	-	-	Poor
9. Pärnu Bay	-	M(2), Zp(3), P(1)	F(4)	C(1)	-	Mod.	Poor	Poor	Poor
10. Gulf of Riga, N	1	M(2), Z(1), F(1), P(1)	F (6)	C(1), N(2)	High	Good	Poor	Bad	Bad
11. Gulf of Riga, S	-	P (2), Z(2)	-	C(1), O(1)	-	Good	-	Mod.	Mod.
12. Curonian lagoon	-	M(2), Z(2), P(2)	-	N(4)	-	Bad	-	Bad	Bad
13. Puck Bay	5	M(3), F(1)	F(2)	-	Bad	Bad	Bad	-	Bad
14. Fehmarn Belt	2	M(6), Z(1), P(1)	-	N(2)	Bad	Mod.	-	Bad	Bad
15. Neustadt Bay	2	M(6), Z(1), P(1)	-	N(2)	Bad	Bad	-	Poor	Bad
16. Bülk	2	M(6), Z(1), P(1)	-	N(2)	Good	Poor	-	Mod.	Poor
17. Gelting Bight	2	M(6), Z(1), P(1)	-	N(2)	Bad	Bad	-	Mod.	Mod.
18. Odense Fjord	2	M(2), P(3)	-	N(7)	Poor	Bad	-	Bad	Bad
19. Limfjorden	-	Z(12), M(4)	-	C(2), N(2)	-	Bad	-	Mod.	Bad
20. Randers Fjord	-	M(2),Z(3), P(2)	-	N(4)	-	Bad	-	Poor	Bad
21. Ise-Roskilde fj.	-	M(2), Z(2)	-	N(1)	-	Bad	-	Bad	Bad
22: The Sound	1	Z(1), M(1), P(2)	-	C(1)	Poor	Mod.	-	Good	Poor

Table 5.4. Baltic Proper sub-basin scale test of the indicator approach to biodiversity assessment.

Category	Reference condition	Unit	Res-ponse	Acceptable deviation	Present Status	EQR-Indicator	Weighting	EQR Category	Category Assessment
I.Landscapes								0,41	Moderate
Anoxic seabed area[8]	18,50	10000 km3	+	50%	44,40	0,417	50%		
Wild salmon rivers[9]	22,00	N rivers	-	50%	9,00	0,409	50%		
II.Communities								0,22	Bad
Threatened biotopes[10]	0,00	N biotopes	+	15%	12,00	12,000	16,6%		
ZB (SE Baltic Proper)	8,00	N taxa	-	40%	1,83	0,229	16,6%		
ZB (E. Gotland basin)	5,30	N taxa	-	39%	0,62	0,117	16,6%		
ZB (Bornholm Sea)	12,40	N taxa	-	40%	2,96	0,239	16,6%		
ZB (N. Baltic Proper)	4,70	N taxa	-	33%	0,00	0,000	16,6%		
ZB (Arkona Sea)	18,33	N taxa	-	27%	14,00	0,764	16,6%		
III.Species								0,504	Bad
White tailed eagle (PS, Baltic)	200,00	N	-	50%	2250,00	1,000	20%		
Established Alien Species 1950-[11]	6,00	Established species	+	15%	14,00	0,429	20%		
E. Baltic Cod SSB[12]	270,00	1000tonnes	-	15%	160,00	0,593	20%		
Threatened and decling species[13]	0,00	N species	+	15%	53,00	0,000	20%		
Common Seal (RI, Kalmarsund)	0,12	Rate of increase	-	25%	0,80	1,000	20%		
IV.Supporting Features								0,68	Moderate
Secchi depth (Baltic Proper, BSAP)	9,3	m	-	25%	6,3	0,68	100%		
Overall Biodiversity status using worst performing category of categories I, II and III = Bad									

8 Entire Baltic according to Savchuk et al 2008

9 Ranke et al (eds) 1999 Baltic Salmon Rivers

10 HELCOM BSEP 113

11 Baltic Sea Alien Database

12 RefCon=ICES long term average, acceptable deviation= ICES Bpa

13 HELCOM BSEP 113

5. FIGURES

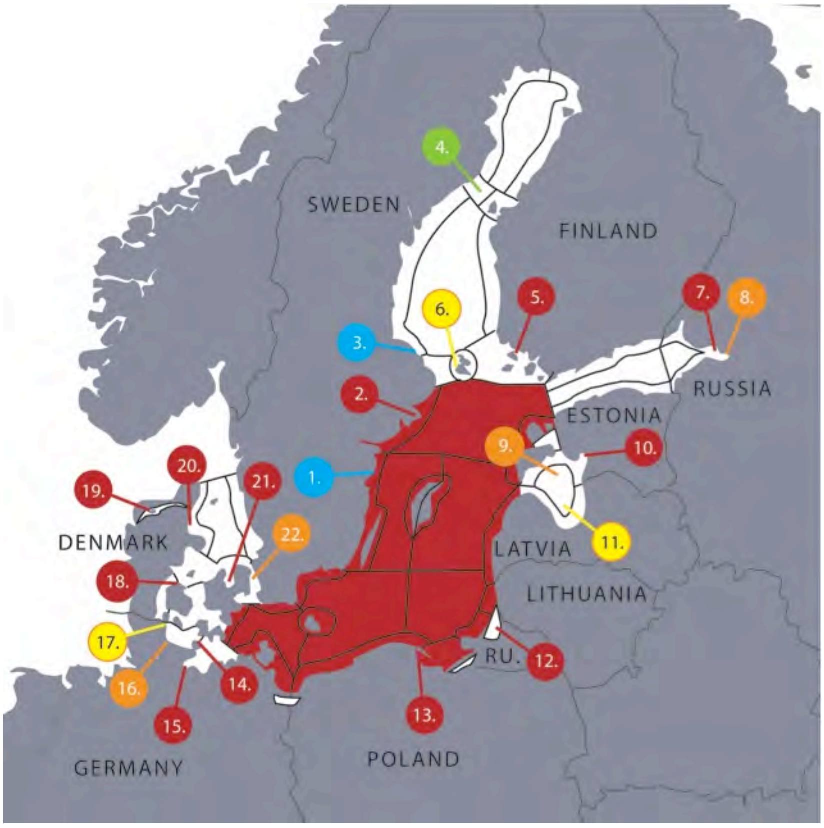


Figure 5.1. Approximate location of national case studies. Colours of the pointers refer to assessment results (see Table 5.3). The Baltic Proper sub basin is assessed as a whole (see Table 5.4).

5. Boxes

Box 5.1 Defining conservation status using the BEAT Approach

The BEAT assessment approach is based on Ecological Quality Ratios (EQR) where EQR= ratio between present status and Reference condition. Using this approach calculation of status is possible if a reference condition, acceptable deviation and present status of a given indicator are available. For indicators which have a numerically positive response to a given pressure factor, e.g. the share of opportunist species the line between Good and Moderate, i.e. between Favourable and unfavourable conservation status is calculated as:

Equation 1: If Present status ≤ RefCon x (1+Acdev in decimal form), i.e. if EQR ≥ 1/(1+Acdev in decimal form), then good status is fulfilled for the indicator in question.

For indicators which have a numerically negative response to degradation (e.g. population sizes of endangered species or distribution/area of endangered habitats) the status is calculated as:

Equation 2: If Present status ≥ RefCon x(1 - Acdev in decimal form), i.e. if EQR≥ (1-Acdev in decimal form) then good status is fulfilled.

Assessment to classes other than the good-moderate boundary (High, Good, Moderate, Poor and Bad) is derived as follows: in terms of EQR the reference condition is set to 1.0-0.95. The boundary between good and high is midway between G/M boundary and 0.95. The same class width is used to define Moderate and Poor and the Poor-Bad boundary is same distance from G/M as 0.95.

CHAPTER 6: HUMAN PRESSURES ON BIODIVERSITY

A human population of approximately 85 million people lives in the drainage area of the Baltic Sea. A great number of different types of human activities taking place in the drainage area, coastal zone and open sea put pressures on the Baltic Sea biodiversity.

Some pressures act on local and others at basin-wide scales. Dredging may for example have a local and short time impact, while eutrophication affects vast areas and is long lasting. Similarly, certain pressures act at the level of species while others have an impact at the greater landscape level of biodiversity (Figure 6.1). Many of the pressures also cause synergetic effects whereby the negative impact of one pressure is exacerbated by an other.

This chapter addresses the magnitude and impacts of different pressures originating from various economic sectors. It mainly depicts human activities that are directly associated with the Baltic Sea and that exert multiple pressures on biodiversity, namely; fisheries, maritime traffic, technical installations, and recreational activities. In addition, the chapter provides an overview of the magnitude and known impact of eutrophication, hazardous substances, alien species, noise and hunting. Predicted change in climate caused by anthropogenic factors is also presented as a case of anticipated future pressure.

Pressures addressed in this chapter include the predominant pressures and impacts for the Baltic Sea biodiversity. They also largely cover the pressures and impacts listed in Annex III, Table 2 of the Marine Strategy Framework Directive (MSFD).

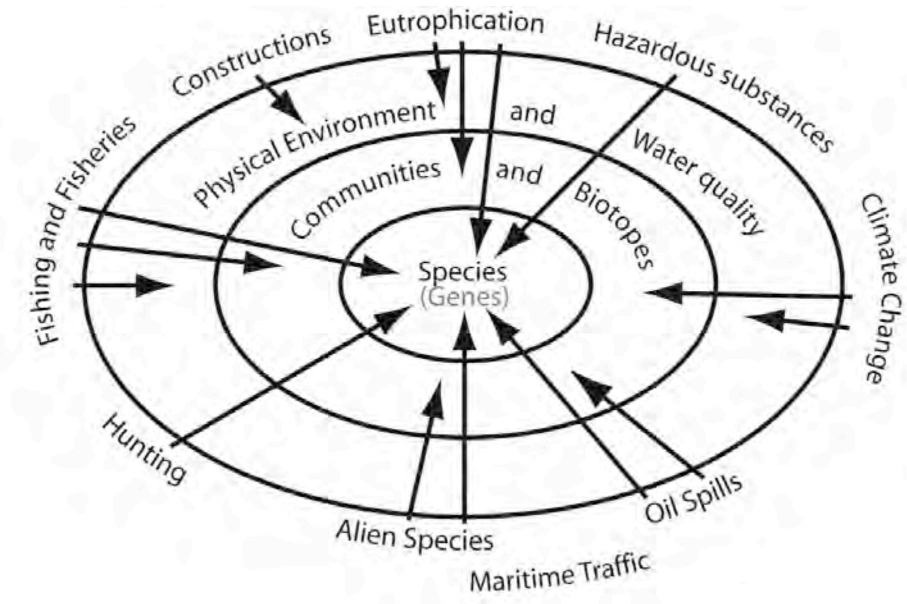


Figure 6.1. Human pressures in the Baltic Sea region act on different levels and scales of biodiversity.

6.1 Fisheries

Fisheries have been an important source of livelihood for people of the Baltic countries for centuries. There are archaeological evidences suggesting that fishing was conducted along the Baltic coasts already since before the Middle Ages (e.g., Makowiecki and van Neer 1996). However, the magnitude of landings and fishing effort is mostly documented for the 20th century while the stock status of the eastern Baltic cod population dates back to the 1920s (Eero 2008) and that of herring and sprat only to the 1970s (ICES 2008a).

There is increasing evidence that the fisheries have substantial impact on the entire Baltic ecosystem. This extends from key abiotic parameters to the upper trophic levels of the food web. The importance of fishing and fish management on the overall state of the Baltic ecosystem is emphasized by the many actions and targets related to fisheries in the Baltic Sea Action Plan (BSAP). Moreover, the BSAP specifically includes the recommendation to implement the ecosystem approach to fisheries management in the Baltic Sea.

6.1.1 Description of fisheries

Cod (*Gadus morhua callarias*), herring (*Clupea harengus membras*), sprat (*Sprattus sprattus*), salmon (*Salmo salar*) and sea trout (*Salmo trutta*) are the internationally assessed and managed fish in the Baltic Sea. All other fish are mostly of local importance and are therefore managed nationally and/or locally. The assessment and management units of the internationally assessed species are provided in Figure 6.1.1.

Pelagic trawls dominate in herring and sprat fishery. Usually, the catch consists of a mixture of these two species whereas their proportion in catch varies by area and season. Herring is also caught by trap-nets/pound-nets and gill nets in coastal areas as well as with bottom trawls. In addition to clupeids, vendace (*Coregonus albula*) is also caught by pelagic trawls in the northern part of the Bothnian Bay. Cod is mostly caught by demersal trawls, pelagic trawls and gillnets. The importance of longlines has increased recently in cod fisheries and this has happened at the expense of gillnet fishery (ICES 2008a). While feeding in the sea, salmon are caught by long lines and during the spawning migration they are caught along the coast, mainly in trap nets and fixed gillnets. In river mouths, set gill nets and trap nets are used (ICES 2008a). Detailed description of the current fisheries by countries, sub-basins and stocks is given by ICES (2008a,b).

The list of other, mostly locally important commercial fish, include such species such as pikeperch (*Sander lucioperca*), pike (*Esox lucius*), perch (*Perca fluviatilis*), vendace, whitefish (*Coregonus lavaretus*), burbot (*Lota lota*) and eel (*Anguilla anguilla*). Coastal fisheries activities take place along the entire coastline of the Baltic Sea. The coastal fishery is usually mixed fishery. As trawling is prohibited in the coastal zone in most of the countries (shallower than 20 m), gears used in coastal fisheries include fixed gears (e.g. gill, pound and trap nets, and weirs) and Danish seines. The selection of gear depends on the target fish and also coastline morphology. Although all Baltic countries keep their own national statistics, there are only estimations available on the total coastal fish landings in the Baltic Sea: about 50 000 tonnes (Lindquist, 2001).

Trends in landings

Out of the major commercial fish stocks, the eastern Baltic cod landings peaked in the 1980s (over 300 000 tonnes annually) and have declined afterwards and remained at very low levels during the last 15 years (last 5-years mean ca 65 000 tonnes). Landings of the western cod exceeded 50 000 tonnes annually from the 1960s until the early 1980s but amounted on average only to a half of this during the last five years. At the same time, sprat landings have substantially increased from below 50 000 tonnes during the mid-1980s to over 350 000 tonnes recently. The main basin herring (incl. Gulf of Finland) have steadily decreased from 300 000 tonnes in the late 1970 to over 100 000 recently. In contrast, the Gulf of Riga herring has increased during the past two decades over two times. Flounder catches have increased since the early 1990s being currently over 15 000 tonnes annually. Dynamics of landings of eleven marine fish species over time is shown in Figure 6.1.2 (ICES 2008). The state of the major Baltic fish stocks is given in Table 6.1.1.

6.1.2 Ecosystem effects of fishing activities

The major impact of fishing is undoubtedly on exploited fish stocks, but also on benthic invertebrate and fish communities, marine mammals, seabirds and the abiotic environment. The effect of fishing on various ecosystem components other than fish is different in the open sea and coastal areas mainly due different fishing gears employed.

Fish stocks

The main ecological effect of fishery is the removal of large quantities of fish, in particular target species. The major effects include, amongst others, decrease of fish abundance and/or spawning stock biomass, decrease of individual size of fish at sea and changed predator-prey interactions. Although the effect of fishing on non-target species is of great importance in the ecosystem perspective, there is only very little known on this topic. Effects of fishing on fish stocks and fish communities are also dealt with in chapter 3 of this report.

An important impact on the ecosystem is also by-catch and discards. Except in cod fishery, the extent of fish by-catch is unknown in the Baltic Sea. The discard estimates for the two Baltic cod stocks are available since 1996 when the sampling was commenced. The western and eastern cod discards have fluctuated during the period of data availability (i.e., 1996-2007) between 5.0-26.6 and 3.7-23.3 million of individuals, respectively. However, the discard estimates are relatively uncertain (ICES 2008a). Calculations show that the amount of cod offal in the entire Baltic Sea (i.e., sub-divisions 22-32) reached the peak in the early 1980s (average ca 58 000 tonnes annually) and was relatively low in the 1990s with annual mean of about 19 000 tonnes (ICES 1997).

Demersal communities

In general, bottom trawls have an impact on marine biota in several ways including (i) reduction in structural biota; (ii) reduction in the geographic range of species; (iii) a decrease in populations that have low rates of turnover; (iv) fragmentation of populations; (v) alteration of the relative abundance of species; (vi) sub-lethal effects on individuals; (vii) an increase in populations that have high rates of turnover; and (viii) favouring populations of scavenging species (ICES, 2000).

There are only a few studies available in the Baltic region on bottom trawling impacts on the marine ecosystem. It has been documented that trawling may cause heavy damage to several species of thin-shelled bivalves and starfish whereas solid shelled bivalves or the more fragile *Macoma baltica* suffer little or no damage. Increased proportion of damage with increasing body size was found for the mussels *Macoma calcarea*, *M. baltica*, *Arctica islandica* and *Musculus niger* (Rumohr and Krost 1991). The same study evidences a considerable impact on benthic communities, and specifically for *A. islandica*. Trawling activities do not necessarily lead to total destruction of benthic communities but rather to resuspension of sediments and dislocation of living organisms, mainly epibenthic organisms. This leads to an increase in predatory and scavenging species (Krost 1990, Rumohr and Krost 1991 and references therein). Bottom trawling has a greater impact on the endofauna than on the epifauna, causing thus higher community evenness and diversity (Krost 1990). However, this effect is relatively regional being confined to southern Baltic Sea.

Marine mammals

The adverse effects of fisheries on seal populations could be summarised as (Pilats 1989): (i) direct killing of seals as competitors to fishery; (ii) accidental drowning of seals in fishing gear, (iii) entanglement of seals in discarded netting, and (iv) decrease in food resources for seals. As seals are generalists in terms of feeding and their main prey is therefore the most abundant fish in the system (Lunneryd 2001), open sea fishery can affect seal populations via reduction of their food resource. In contrast, coastal fishery directly impact survival of seals as they can entangle into the static gears employed by the coastal fishery (like trapnets and gillnets). It has been estimated that at least 300 grey seals, 80 ringed seals and 7–8 harbour seals are captured as by-catch annually in the Baltic Sea (ICES 1995). Further estimates are available for the Swedish Baltic Sea coastal fisheries where in total over 400 grey seals and 50 ringed seals were by-caught in 2001 (Lunneryd et al., 2005).

The annual by-catch rate of harbour porpoises was estimated to amount to 25 porpoises in bottom trawls and 89 porpoises in gillnets, trammel nets and pelagic trawls in the Swedish part of the Skagerrak and Kattegat (ASCOBANS, 2008). In the German part of the Baltic Sea, most of the 105 recorded by-caught porpoises of the years 1990 to 2001 were reported from bottom-set gillnet fisheries or stranded with characteristic netmarks (Siebert et al. 2006). While these numbers are minimum figures, Rubsch & Kock (2004) estimated the annual by-catch in the German setnet fishery to be 57 individuals in the western Baltic Sea and 25 in the German part of the Baltic Proper. A total of 45 by-caught animals were reported from Polish waters between 1990 and 1999 (Skóra & Kuklik 2003). In Latvia, two porpoises were found entangled in fishing nets in the Gulf of Riga in October 2003 and in January 2004, respectively (ASCOBANS 2004). A modeling study by Berggren et al.

(2002) has estimated the potential limits to anthropogenic mortality for harbour porpoises. To achieve the goal of population recovery to more than 80% of carrying capacity, by-catch limits of 2 individuals per year in the Baltic Proper and 3 individuals per year in the Kiel Bight–Mecklenburg Bight area should not be exceeded.

Seabirds

Several studies from different parts of the Baltic Sea have shown that set net (gillnet) fishery in the Baltic Sea causes the death of tens of thousands of birds every year. The by-catch problem is of special relevance where gillnet fishery is practised in areas with high concentrations of resting, moulting or wintering seabirds. The conflicts are usually seasonal.

Piscivorous birds (divers, grebes, mergansers, auks, cormorants) and benthophagic ducks may get entangled and die in fishing gear. At the southern coast of the Baltic Sea, the long-tailed duck (*Clangula hyemalis*) is the most numerous species caught in gillnets, followed by black scoter (*Melanitta nigra*), common scoter (*Melanitta fusca*) and red-throated diver (*Gavia stellata*) while in some areas, eider (*Somateria mollissima*), greater scaup (*Aythya marila*), guillemot (*Uria alge*) and cormorants (*Phalacrocorax carbo*) are also found in high numbers (I.L.N. & IfAÖ 2005, Schirmeister 2003, Stempniewicz 1994, Kirchhoff 1982, Kowalski & Manikowski 1982). In the coastal waters of Lithuania, losses of Steller's eiders is of concern because of the rareness of this species (Dagys & Žydelis 2002). In Finland, especially eider, black guillemot (*Cepphus grylle*), razorbill (*Alca torda*) and red-throated and black-throated divers (*G. stellata* and *G. arctica*) are the most affected species (Hario 1998). The most recent Swedish by-catch study covering the Swedish fishery as a whole (Lunneryd et al. 2004) showed that the cormorant was the dominating species, followed by eider, guillemot, mergansers, and long-tailed duck. The specific threat to drowning in fishing gear is higher for piscivorous species than for benthophagic ducks, though total numbers of the latter group in most areas are lower because of lower population numbers. The available studies are mainly investigating bird by-catch in near-coastal waters. Information about the by-catch on fishing grounds further offshore is scarce, though it is known that high densities of birds and high fishing intensity seasonally may overlap also in these areas.

Another effect of fisheries on birds is related to the discard of unwanted catch and offal on sea. Especially gulls are benefiting from this food source. Furthermore, the increase of sprat stocks as a consequence of cod overfishing is supposed to have a positive effect on piscivorous birds, especially auks.

Abiotic environment

In general, the effects of bottom towed gears on abiotic habitats are primarily (i) removal of physical features, (ii) reduction in complexity, and (iii) alteration of the physical structure of the sea floor (ICES 2005).

Towed demersal fishing gears can substantially affect abiotic environment also in the Baltic region, where this fishing practice is applied. For instance, in the intensely fished Kiel Bight, the total disturbed area was estimated to 630 km^2 per year whereas mobilisation of nutrients was estimated to be 0.6–2.5 tonnes silicate, 0.3–1.3 tonnes nitrogen and 0.1–0.5 tonnes phosphorus per km^2 and year. The increase in nutrient concentrations was followed by an increase in oxygen consumption of 1.5–7.8 tonnes per km^2 and year. This points to a considerable impact of fishing activities on the marine environment (Krost et al. 1990). There is no documented evidence that traditional coastal fishery (e.g., by means of trapnets and gillnets) has affected the abiotic environment.

6.1.3 Major international frameworks that regulate fisheries in the Baltic Sea

Major Baltic fish stocks are managed by a system evolved under the EU Common Fisheries Policy (CFP). The objective of the CFP is sustainable exploitation and equitable distribution of a resource which is under constant change. The scientific advice for fisheries management is obtained from the International Council for the Exploration of the Sea (ICES). However, fisheries management in the European Union is under change. There has been a move towards greater involvement of stakeholders in fisheries management. In addition, there has been a move towards management on more regional scale. As a result of this change, Regional Advisory Councils (RACs) have been recently established for a number of seas and fisheries to try to bring a wide range of interest groups together to discuss and deliver management advice on fisheries.

6.1.4 Conclusions

Fisheries have substantial impact on the Baltic ecosystem level extending from the abiotic environment to the upper trophic levels of the marine food web, including mammals and sea birds. These evidences are accumulating continuously and the effects strongly point to the urgent need for effective implementation of Ecosystem Approach to Fisheries Management (EAM). A critical evaluation of the related targets listed in the BSAP indicate that not all of them are likely to be achievable within the indicated time-line e.g., "By 2009 illegal, unregulated and unreported fisheries are close to zero". However, a further and more detailed evaluation is needed, especially given the aspect that there are many activities that needs to be undertaken almost in parallel meaning potential problems in allocation of finances and human resources.

6.1 TABLES

Table 6.1.1. Catch range in the past 5 years and the current state of the selected major Baltic commercial fish stocks (ICES 2008a,c)

Stock	Catch range in past 5 years (2003-2007, 10^3 tonnes)	SSB in relation to precautionary limits	F in relation to precautionary limits	F in relation to high long-term yield
Western cod	20-24	Increased risk	Undefined	Overfished
Eastern cod	50-71	Undefined	Harvested sustainably	Overfished
Herring in SD 25-29 (excl. GoR) and 32	91-116	Undefined	Harvested sustainably	Underfished
Gulf of Riga herring	31-40	Undefined	Harvested sustainably	Overfished
Sprat	308-405	Unknown	Increased risk	Overfished
Flounder	15-19	Unknown	Unknown	Unknown

6.1 FIGURES

Figure 6.1.1. Baltic Sea subdivisions of the International Council for the Exploration of the Sea (ICES). Assessment and management units of the main fish species are the following: Herring: the main Basin (incl. Gulf of Finland; ICES subdivisions 25-29 and 32; excl. Gulf of Riga); Bothnian Bay (SD 31), Bothinan Sea (SD 30) and Gulf of Riga (SD 28.1); Cod: eastern (SD 25-32) and western (SD 22-24) stocks; Sprat: one single stock (SD 22-32); and Salmon: Main Bain and Gulf of Bothnia stocks (incl. the following separate assessment units: Northeastern Bothnian Bay; Western Bothnian Bay; Bothnian Sea, Western Main Basin, Eastern Main Basin) (SD 22-31) and Gulf of Finland (SD 32).

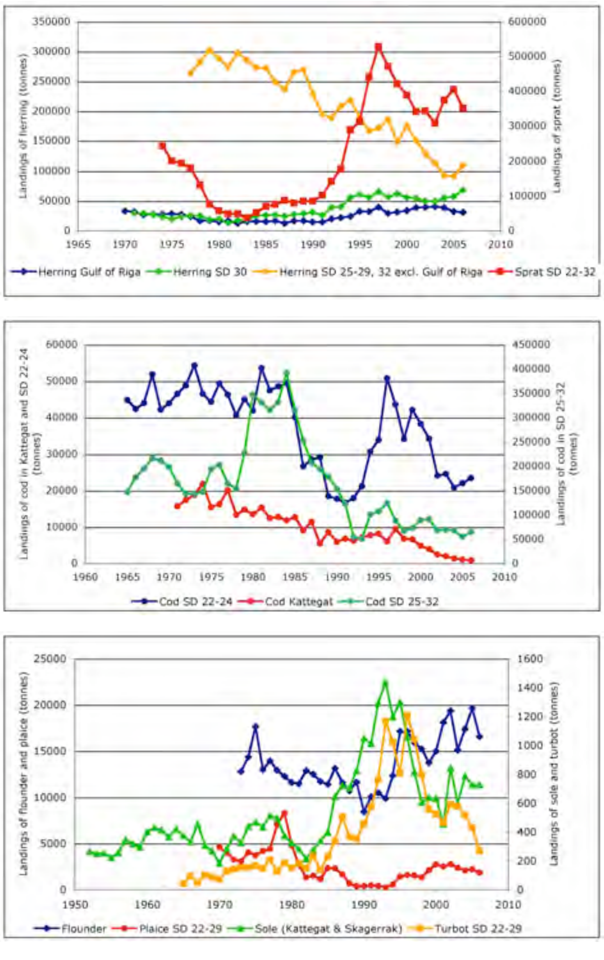


Figure 6.1.2. Dynamics of landings of eleven major fish stocks/species in the Baltic Sea during 1952-2006 (ICES 2008a).

6.2 Maritime activities

Roughly 15% of world's commercial fleet sail in the Baltic Sea. More than one tanker per hour passes the intensively trafficked spots totalling over 10 000 passages annually. The maritime transport in the Baltic is expected to grow further by 64% between 2003 and 2020 (Anon. 2006).

Maritime traffic contributes with multiple pressures on the Baltic Sea biodiversity including nutrient release, oil spills, and spread of alien species. Several marine protected areas (MPAs) – set to protect the unique marine nature of the Baltic Sea from human impact – are close to heavily trafficked areas (Figure 6.2.1).

Maritime traffic is one of the four main segments addressed in the Baltic Sea Action Plan (BSAP). Several management objectives have been outlined to indicate the main areas of concern including e.g. "Safe maritime traffic without accidental pollution", "Minimum sewage pollution from ships", "No introductions of alien species from ships", and "Minimum air pollution from ships".

6.2.1 Impacts of maritime traffic on biodiversity

Physical impacts

Heavy shipping has direct negative impacts on marine biodiversity, especially in shallow areas. Ship-generated water flow reform the coastal zone (Soomere 2005), recirculate nutrients in the water column thus enhancing eutrophication (Lindholm et al 2001) and change species composition in rock pools due to wave wash (Östman & Rönnberg 1991). Decline and structural changes in coastal fish communities may be linked to increased shipping due to coastal erosion and increased sedimentation and eutrophication (Rajasilta et al. 1999). Maritime traffic is also a significant producer of marine litter, even if the amount of litter is smaller in the Baltic Sea than some other parts of the world (HELCOM 2007). Ship hulls, as well as ballast waters and sediments, transport alien organisms to the Baltic Sea (see this chapter, Alien species) and anti-fouling chemicals used on ship hulls cause acute effects on organisms, especially at lower levels of the trophic web (see this chapter, Hazardous substances).

Although maritime traffic considerably increases noise both underwater and above the surface, it has not been found to cause acute harm to marine animals, but may potentially disturb harbour porpoises (see this chapter, Noise pollution).

Oil spills

Oil turnover in oil terminals around the Baltic Sea has increased steadily during the last years (Figure 6.2.2). Together with the expected increase in marine traffic, this means that the risk for a major oil accident in the area is increasing. Despite increasing preparedness of HELCOM Contracting Parties, an oil spill would have severe impacts both in offshore and coastal areas. The major Prestige oil accident in the Atlantic coast of Spain in 2002 caused significant short-term reduction in phyto- and zooplankton biomass (Mendes et al. 2005), reduced abundance and species richness of littoral invertebrates (ICES 2007), reduced fish reproduction (Dominguez & Saborido-Rey 2005), killed or harmed about 200 000 birds (Zuberogoitia et al. 2006), stranded marine mammals and turtles (López et al. 2005), and caused significant egg and adult mortality of peregrine falcons (Zuberogoitia et al. 2006).

In spite of dramatically increasing oil transportation, most oil spills detected in the Baltic are small illegal or accidental spills, which seem to have decreased during the recent years, possibly due to better enforcement (Figure 6.2.3). However, oil has direct harmful impacts as oiled birds and mammals suffer from hypothermia, which often leads to death, in particular of the avian fauna. Annually, 100 000-500 000 ducks, guillemots and other bird species are estimated to die due to small oil spills in the Baltic Sea (BirdLife 2007). This highlights the significance of cumulative effects of smaller spills to Baltic biodiversity. Cascading ecosystem effects of oil from phytoplankton to higher trophic levels are poorly known, but expected to be harmful due to decreased food availability and increased bioaccumulation of toxic chemicals.

Nutrient loads

Intensified shipping activity contributes to the eutrophication of the Baltic Sea through airborne input of nitrogen oxides (NO_x) as well as sewage discharges (for impacts on biodiversity, see this chapter, Eutrophication). NO_x emitted to air is deposited both directly to the sea surface and to the catchment area, from where they drain into the sea via rivers.

According to the Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe, EMEP (Bartnicki 2007), shipping in the Baltic Sea contributed 9% of the total airborne N deposition directly to the sea in 2005. As the major share of nutrients to the Baltic enters as waterborne input from the catchment area (Knuuttila 2007), shipping contributed only about 2% of the total N inputs to the Baltic Sea (Table 6.2.1). A recent study, however, suggests that, based on NO_x emissions from ships, N depositions may be higher than previously estimated (Stipa et al. 2007).

With a projection of 2.6% annual increase in shipping traffic in the Baltic, and assuming no abatement measures, the estimated annual input of NO_x from maritime traffic alone has been estimated to increase by roughly 50% until 2030 (Stipa et al. 2007, IMO document MEPC 57/INF14). The scenarios show that only the strictest proposal under consideration by IMO, i.e. 80% reduction of emissions from marine diesel engines installed on ships on or after 1 January 2015, would counteract this development (IMO document BLG 11/16, Stipa et al. 2007).

Nitrogen loads to the Baltic Sea originating from ships' sewage discharge have been estimated to represent about 0.05% of the total waterborne nitrogen load, and up to 0.5% of the total phosphorus load into the Baltic Sea (Table 6.2.1) (Huhta et al. 2007). These figures are calculated based on the assumption that there is no sewage treatment onboard ships (cargo ships, cruise ships and passenger/car ferries) and that all sewage is discharged into the sea, i.e. the theoretical worst case scenario. The proportion of nutrients originating from ships' sewage water is thus relatively small compared to the total load to the Baltic Sea. The waste water discharges may nevertheless have considerable effects on the growth of pelagic phytoplankton because the nutrients are directly available in the open sea. The total N discharges from commercial traffic is comparable to the 500 tonnes annual nitrogen load from the city of Helsinki waste water treatment plant which purifies the waste waters of approximately 1 million people (Huuska and Miinalainen 2007).

6.2.2 Major international frameworks that regulate maritime traffic

The International Convention on the Prevention of Pollution from Ships (MARPOL 73/78, amended 1997) is the major regulating tool by the International Maritime Organization (IMO) regarding environmental issues, setting in its ANNEX VI inter alia limits for the emissions of NO_x, SO_x and particulate matter and prohibiting emissions of ozone depleting substances. In 2006 the Baltic Sea Sulphur Emission Control Area (SECA) entered into force and discussionshave been initiated to limit also NO_x emissions. In 2005 Baltic Sea[14] was designated by IMO as a Particularly Sensitive Sea Area (PSSA). Presently the status imposes restrictions to shipping in the Baltic via traffic separation schemes, deep-sea routeing and areas to be avoided.

The International Convention on the Control of Harmful Anti-fouling Systems on Ships entered into Force in September 2008 and reduces the amount of toxic chemicals in the marine environment. The Convention for the Control and Management of Ships' Ballast Water and Sediments has not yet been ratified but will be one of the main international instruments addressing alien species introductions. The Baltic Sea Action Plan also states that the Baltic Sea countries will encourage shipping companies to use crew trained for winter navigation and use pilots on a voluntary basis.

To eliminate discharges of oily waste, sewage and garbage, HELCOM has established a "no-special-fee" system for ports. Most of the Baltic Sea countries have reported that the coverage of the "no-special-fee" system has already been duly extended in their ports.

14 Excluding waters of the Russian Federation

Currently, HELCOM is considering new regulations on restrictions for the discharge of sewage from passenger ships into the Baltic Sea, as well as a joint proposal of the Baltic Sea countries to be submitted to IMO to amend the existing sewage treatment regulations (Annex IV to the MARPOL 73/78) to cover also nutrients.

6.2.3 Conclusions

The impact of maritime traffic on the Baltic biodiversity is both direct, in the form of physical disturbances and nutrient and chemical pollution, and indirect, for example acting as vector for non-indigenous species (Figure 6.2.4). The risk for a major oil accident is growing due to increasing tanker traffic in the area but also smaller spills have a considerable effect. Although most of the shipping in the Baltic Sea follows narrow routes through the sea area, almost no corner in the Baltic Sea is unaffected by shipping as shown by the recent AIS (Automatic Identification System) data (Figure 6.2.1). Further work to streamline environmental and maritime traffic regulations is needed to minimise the harmful effects of the increasing maritime traffic in the Baltic Sea.

6.2 TABLES

Table 6.2.1. Magnitude of nutrient (nitrogen and phosphorus) inputs from shipping in 2000, and total waterborne and airborne loading in 2005, to the Baltic Sea.

Nitrogen source	Total N in thousand tonnes	NO_x in thousand tonnes
Airborne N from Baltic shipping [1]	19	14
Sewage N from Baltic shipping [2]	0.47	-
Total deposition of airborne N to the Baltic Sea[1]	208	86
Waterborne loading of N to the Baltic Sea [1]	620	300

Phosphorus source	Total P in thousands tonnes	
Sewage P from Baltic shipping [2]	0.16	-
Waterborne loading of P to the Baltic Sea [1]	29	-

[1)] HELCOM Indicator fact sheet 2007. [2)] Huhta et al. 2007.

6.2 FIGURES

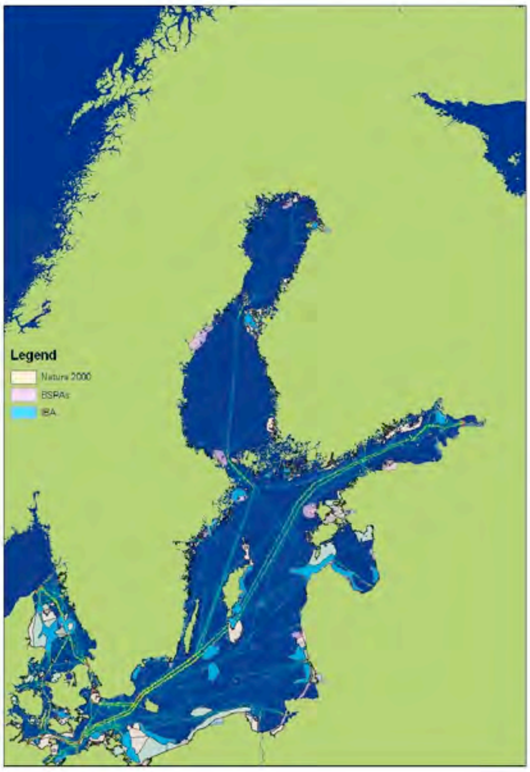


Figure 6.2.1. Shipping density based on data in the HELCOM Automatic Identification System (AIS) in February 2007, shown here together with Baltic Sea Protected Areas (BSPA), Natura 2000 areas and Important Bird Areas (IBA). Many of the protected areas are overlapping and are shown in the order indicated in the figure legend, from top to down.

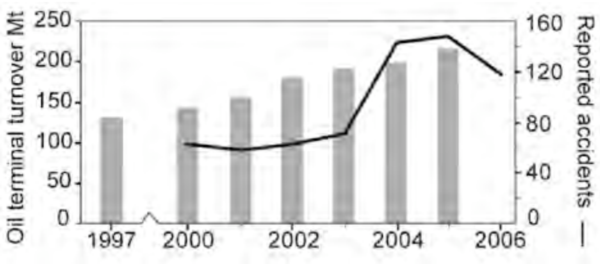


Figure 6.2.2. Total oil turnover in major Baltic terminals (handling >3 million tonnes per year). The line represents the number of reported accidents for the same time period.

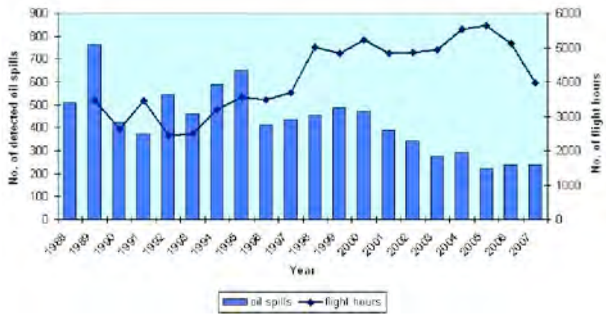


Figure 6.2.3. Detected illegal oil spills from airborne monitoring 1988-2007. The number of flight hours is shown by the black line. Based on HELCOM aerial surveillance data.

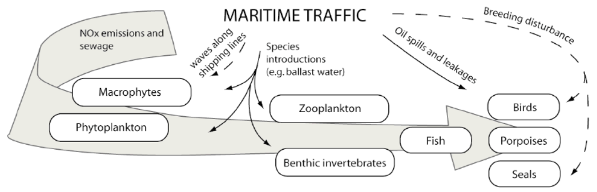


Figure 6.2.4. A conceptual model of the impacts of maritime traffic on components of Baltic biodiversity.

6.3 Physical damage and disturbance

Human activities discussed in this chapter can be classified into three major types: extraction of sand and gravel, dumping of dredge spoils and effects of different construction works. The harmful effects of these activities are caused by largely similar processes: resuspension of nutrients and hazardous substances, increased turbidity, siltation and habitat loss. Operation of different installations are linked to diverse effects including disturbance from underwater noise, magnetic fields and also by the introduction of new habitats.

6.3.1 Extraction and disposal activities in the Baltic Sea

Extraction of bottom substrates

Extraction of sand gravel from the seafloor has increased markedly in many HELCOM Contracting States during recent years. The marine areas considered suitable for mining resources from the seabed have been until recently restricted to areas less than 80 meters, but nowadays depths down to 100 meter can be exploited cost-effectively due to more efficient and powerful dredgers (UNEP GPA 2008).

In 2006 the extraction volume in Denmark (HELCOM area) was 1.6 million m^3, in Finland 2.2 million m^3 and in Germany (HELCOM area) 1.4 million m^3. In Estonia the volume in 2004 was 1.4 million m^3 and in Poland it was 0.5 million m^3 in 2002 (ICES 2003, 2005, 2007). In Poland and Germany marine sand is extracted mainly for coastal defence purposes. The total extraction volume in the Baltic Sea is approximately 5-10% of that in the NorthEast Atlantic (ICES 2003).

After the construction of the Öresund bridge between Sweden and Denmark, there has been no permitted marine sand extraction in Sweden. The amount extracted within that project in the Swedish EEZ was 2.5 million m^3. When the fairway to the Gothenburg harbour was deepened in 2003, 12 million m^3 were dredged (ICES 2006). In general, port constructions and enlargements are among the largest dredging and landfill projects. For example, during the the enlargement of the Århus port in Denmark 8 million m^3 sand was dredged from Århus Bight and in the new port of Helsinki, Finland, the volume was 4 million m^3. An overview of the Baltic ports (www.bpoports.com) shows that there are enlargement plans for most of them.

Disposal of dredged material at sea

It is difficult to get an overview of the current volume of disposal of dredged material at sea in the HELCOM area. HELCOM Contracting Parties have an obligation, based on Article 11 and Annex V of Helsinki Convention and the connected Guidelines (adopted in 2007), to report on the disposal. Currently, there is information available only from Sweden (153 000 tonnes in 2006), Germany (450 000 and 50 000 tonnes in 2006 and 2007, respectively), and Lithuania (1.39 million tonnes in 2007). Obviously, the volume of disposed spoils varies annually depending on large construction projects, such as port enlargements. HELCOM Contracting Parties have agreed on using the Best Environmental Practice (BEP) approach to minimise both the quantity of material that has to be dredged and the impact of the dredging and disposal activities in the maritime area. Moreover, when evaluating disposal sites, comprehensive information on natural features and human activities should be obtained for EIA.

Ecosystem impacts of sand and gravel extraction, small-scale dredging and dumping of dredged spoils

The harmful impacts of sand and gravel extraction, dumping of dredged spoils and dredging on marine ecosystem are mainly caused by increased turbidity, siltation and resuspension of nutrients and hazardous substances (reviewed by HELCOM 1999). For example, the spill of sand from the dredging operation in the Århus harbour enlargement was estimated to be 3.7% and resuspension of inorganic nitrogen and phosphorus was estimated to increase the nutrient concentration in the water phase 3-100 fold (ICES 2003).

Extraction activities destroy, at least temporarily, the vegetation and benthic fauna of the dredged area. After minor sand extractions, benthic invertebrate communities are usually restored after 2-4 years, but after major sand extraction the recovery phase lasts much longer (e.g. Boyd et al. 2005). In the Baltic Sea, benthic species richness has been found to recover within a year after finishing the activities, whereas biomass and density remain low for several years (HELCOM 1999). However, water currents have shown to spread the plume of fine sand up to 4 km away from the site of activity. Although the observed negative impact on benthos at that distance may be minor and short-lasting (Lisberg et al. 2002, Marine Ecological Surveys Ltd 2003, Vatanen & Haikonen 2008), siltation and overflowing sand may drastically change the species composition of the benthic fauna. At an extraction site in the English Channel this effect reduced the species richness by half, and decreased the density and biomass down to 10% of that in nearby areas (Harlay et al. 2003).

Small-scale dredging in marinas, boat routes and private shores have potentially large local negative impact on biodiversity, because they are often located in sheltered bays, coastal lagoons and estuaries, which support rich submerged vegetation and associated fauna (Dahlgren & Kautsky, 2004 (see also this chapter, Recreational activities). Some sensitive species, such as *Chara* spp., have disappeared from areas exposed to small-scale dredging (Appelgren & Mattila 2005). Dredged spoils from port sediments often contain substances toxic to marine organisms (Smith et al. 1995).

6.3.2 Technical installations

There is a growing number of construction works and different types of installations on the Baltic coasts but also in offshore areas and seabed: traffic links, high voltage power cables (HVPC), oil platforms, oil and gas terminals, pipelines, wind farms, marinas and ports and numerous coastal protection barriers. This section provides an overview of existing large installations and their known impact on the Baltic biodiversity.

Communication links

There are a number of communication links (mainly bridges) connecting cities and/or countries in the Baltic Sea. One of the major projects finalised during the last decades is the communication link between Denmark and Sweden (bridge combined with tunnel and an artificial island) (Figure 6.3.1, left). Other large scale constructions include the Öland Bridge, the Great Belt Fixed Link, or the St. Petersburg flood barrier and communication link (Figure 6.3.1, right). Currently a plan to build the world longest bridge from Germany to Denmark over the Fehrmanbelt marine protected area is adopted by the Danish and the German governments.

Environmental concerns connected with the construction of communication links are usually related to mechanical damage of bottom and release of sediment plumes during the construction phase i.e. they are causing the ecosystem effects that have been described above after dredging. After construction, bridges may affect water exchange. The underwater parts of bridges introduce a new habitat that provides good attachment sites for sessile organisms (Elsam Engineering & ENERGI E2 2005).

Power and communication cables

Power cables have a long history in the Baltic; one of the first cables in the world was the “Gotland”, which connects the island of Gotland with the Swedish mainland. The present cable network in the Baltic Sea consists of nine high voltage direct current lines (HVDC) (Figure 6.3.2, left). The most recent cable connection is the “SwePol Link” (230 km, 450 kV). In addition to power cables, there are several existing and planned communication cables across the southern sea basins (e.g. www.bsh.de/en).

Ecological effects of underwater power transmission lines include mechanical damage to bottom (during cable layering), release of toxic chlorine during electrolysis (in one cable solution) and possible influence of electromagnetic field on migrating fish. However, the relative importance of these is probably low (Andrulewicz et al. 2003).

Oil and gas exploitation platforms

Oil and gas in the Baltic Sea is extracted by two oil platforms; “Petrobaltic” in the Polish exclusive economical zone (EEZ), and “D-6” in the Russian sector of Kaliningrad Oblast (started in 2006). The operation of these oil platforms has not been observed to cause any significant environmental problems. However, oil and gas extraction activities may grow in the Baltic Sea and therefore may be recognized as a potential environmental concern (for impact, see this chapter, Maritime activities).

Ports, oil terminals and piers

Ports, oil terminals and piers are constructed in many places along the Baltic Sea coast. The annual throughput of the 51 member ports of the Baltic Ports Organization (BPO) is: 400 million tonnes of cargo, 3.3 million containers, 60 million passengers and 200 000 port calls (www.bpoports.com). The capacity of Baltic ports is constantly increasing and almost all Baltic ports have raised new development projects. Large development projects are set-up for Primorsk, Ust-Luga and St. Petersburg in Russia; Ventspills, Riga and Liepaja in Latvia; Klaipeda in Lithuania; Tallinn and Sillamae in Estonia; and Gdańsk and Świnoujście in Poland.

Traditionally ports have been constructed in estuaries, which are biotopes of high biological value. Ports are also places of increased risk of accidental pollution, emission of contaminants to atmosphere and sea, and introduction of alien species. Construction of ports leads generally to the degradation of the seafloor and coastal habitats and alteration of coastal currents. For example, in the construction of the new port of Helsinki, extensive environmental monitoring showed temporal increase of TBT in bivalves, deteriorated spawning of herring and degraded macroalgal zonation (Vatanen & Haikonen 2008). However, impacts such as increased turbidity remained smaller than expected on nearby areas and the construction work did not visibly affect marine or coastal bird populations (Yrjölä 2007).

Offshore wind power farms

Although there are currently only a few large wind farms in operation in the Baltic Sea, there are numerous planned (Figure 6.3.2, right) or already going through an EIA process. Despite the fact that wind farms are not a source of chemical or biological pollution, they remain controversial. They may pose environmental effects such as: i) the possibility of bird collisions, ii) emission of noise and vibration, iii) possible disruption of fish migration, iv) loss of feeding and spawning grounds, v) creation of electromagnetic fields, vi) possible alterations of sea currents, and vii) changes of the natural landscape.

According to recent studies on wind farms, their construction phase causes more harmful effects on the environment than the operational phase (Prins et al, 2008). The reactions of fish and mammals to noise, vibrations and electromagnetic fields created by wind farms are still rather poorly known but there are several ongoing projects addressing the issue. At the Nystedt wind farm in the southern Baltic Sea, harbour porpoises clearly avoid the operating wind farm area, possibly due to noise pollution (Elsam Engineering & ENERGI E2 2005). On the other hand, on the North Sea side such behaviour has not been found and seals do not seem to avoid wind farms at all (see also this chapter, Noise pollution). Power cables (132 kV) from wind farms may have a harmful effect on migration patterns of eel and other fish, but the result is not clear and needs further studies (Elsam Enginreering & ENERGI E2 2005). Migrating birds avoid wind farms, showing similar or lower collision frequencies than to any other object (Desholm 2006). However, white-tailed eagles have been found to be vulnerable to wind mills (BBC 2006). For sure, wind power farms change the appearance of the original landscape/seascape (DONG Energy et al. 2006).

Habitat effects are not only negative since even if wind farms modify the natural environment they also increase hard substrata facilitating the development of communities of sessile organisms i.e. the so called reef effect. As a result, wind power farms enhance local biodiversity (algae, invertebrates and reef fish) (Elsam Engineering & ENERGI E2 2005, DONG Energy et al. 2006).

Coastal defense barriers

Numerous coastal defense barriers (sea walls) and beach nourishment are constructed in the southern part of the Baltic Sea, mainly in Denmark, Germany, Lithuania and Poland. These kinds of constructions usually involve massive dredging (physically affecting benthic organisms) and landfill causing disruption of coastal dynamics and loss of coastal habitats (Figure 6.3.3, left). The scale of environmental effects of these constructions depends on the type and size of construction and construction area. Coastal habitats and wetlands, with associated species, show currently a decreasing trend in Europe (EEA 2006).

Gas pipelines

Currently there are at least three planned gas pipeline routes in the Baltic Sea: “Baltic Gas Interconnector” from Germany to Sweden, “BalticPipe” from Denmark to Poland and “Nord Stream” from Russia to Germany. The largest of the three, Nord Stream construction (Figure 6.3.4. right), will consist of two pipelines, both 1200 km long, with a diameter of 122 cm, under a pressure of 220 atm. The size and length of the Nord Stream gas pipes poses a number environmental safety concerns related to: i) effects of construction on bottom habitats and bottom organisms, ii) effects of possible contacts with chemical weapons dumped in the Baltic Sea, iii) effects of mobilisation of nutrients and hazardous substances deposited in sediments, iv) effects of discharged toxic test waters into the sea, v) effects of possible pipeline brakeage.

6.3.3 Major international frameworks that regulate extraction of bottom substrates, dumping of dredged spoils and construction works

Exploitation of marine bottom substrates, dumping dredged spoils and construction of coastal and offshore installations cover such a wide array of actions that there are several international conventions, directives and recommendations regulating their use. The earliest international effort was the London Convention (1972, revised 1996), soon followed by the Helsinki Convention (1974, article 9), which both regulate inter alia dumping of dredged spoils. In the Helsinki Convention, Article 11 on Prevention of dumping (and Annex V and adopted Guidelines in 2007) requires that all dumping must be approved by national authorities and hazardous substances must not be allowed to be dumped at sea. Moreover, Recommendation 19/1 (adopted 1998) states guidelines for marine sediment extraction, requires environmental impact assessments, and limits the extraction activities in sensitive areas and prohibits the activity within marine protected areas. The Espoo Convention (1991), regarding transboundary environmental impacts, has been ratified by eight of the nine Baltic Sea countries.

To protect the Baltic Sea from negative effects of large-scale installations and construction works, HELCOM has developed and adopted a special recommendation on: Information and consultation with regard to construction of new installations affecting the Baltic Sea (Recommendation 17/3). A number of other HELCOM recommendations are applicable to construction works, particularly Recommendation 15/1 regarding protection of coastal strip, Recommendation 16/3 regarding preservation of natural coastal dynamics, Recommendation 19/17 regarding pollution from offshore units, and Recommendation 21/4 on Protection of heavily endangered or immediately threatened marine and coastal biotopes in the Baltic Sea area.

Within the European Union, at least four directives deal directly with construction, extraction and dumping activities in the sea (EIA Directive, Habitats Directive, Birds Directive and Water Framework Directive). Also the EU Recommendation on Integrated Coastal Zone Management regulates the uses of coastal marine areas.

6.3.4 Conclusions

Altered water quality, habitat damage or loss, and underwater noise are the ultimate factors reducing biodiversity in area subject to marine sediment extraction, dumping and installation activities. Directives, recommendations and conventions provide several guidelines aiming to mitigate the negative effects on biodiversity, while the pressure to use marine areas and exploit sediment is steadily increasing.

In contrast to sediment extraction and dumping of dredged spoils, the various pressures from technical installations and construction works are often not recognized and rarely sufficiently understood. The growing number and scale of technical installations and construction works in the Baltic Sea generate new pressures on the marine ecosystem, interacting with all components of the ecosystem (Figure 6.3.4). There is clearly a need for better (international) information exchange on the extent as well as on the environmental effects of the existing large-scale installations. Gaining a regional overview over the extent, effects and future developments of the issues presented here is an important component of Marine Spatial Planning (MSP) launched by the HELCOM Baltic Sea Action Plan (Recommendation 28E/9). The process of Baltic regional MSP aims to improve integration of regional environmental and sectoral policies using e.g. Strategic Environmental Assessments (SEA) and a long-term development perspective.

6.3 FIGURES

Figure 6.3.1. Left: “Öresund Link” connecting Denmark and Sweden. Right: satellite image of the St. Petersburg flood barrier and a bye-pass road off St. Petersburg (under construction) (picture based on the www portal http://maps.google.com).

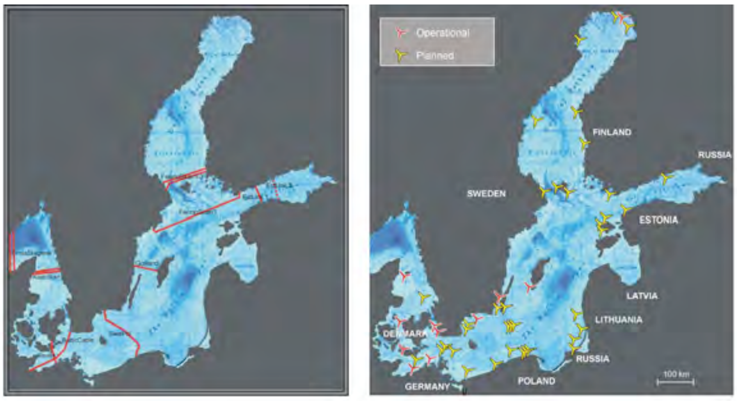


Figure 6.3.2. Left: High voltage electric power cables in the Baltic Sea. Right: Location and status of wind power farms in the Baltic Sea (Compiled from: BSH - German Hydrographic Agency; EWEA - The Europe. Wind Energy Assoc; Elsam Engineering A/S, 2004 – Denmark; Georg Martin – Estonia; Maritime Offices – Poland; Pasi Laihonen – Finland; Ulla Li Zweifel –Sweden; www.vattenfall.se)

Figure 6.3.3. Left: concrete-stone coastal protection on some parts of the Hel Peninsula in Poland (Photo: K. Skóra). Right: planned route of the Nord Stream pipeline (www.nord-stream.com).

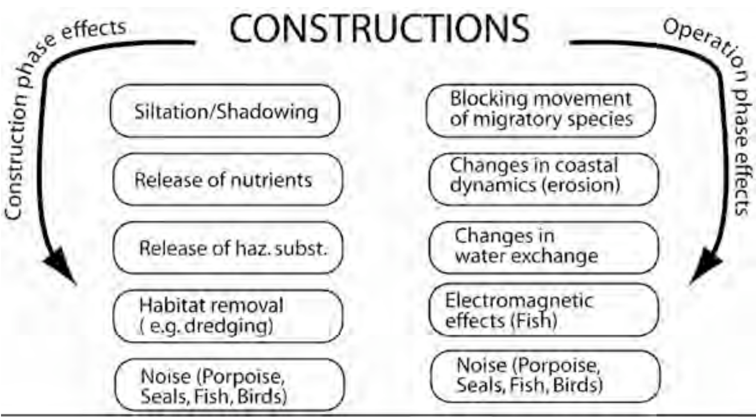


Figure 6.3.4. A conceptual approach to environmental effects of technical constructions.

6.4 Recreational activities

Millions of people are engaged in boating, fishing and bathing in the Baltic Sea every year. The recreational value of the Baltic Sea area depends on a healthy ecosystem and pleasant environment, both with regard to individual appreciation and economic revenue for the tourism sector. At the same time these activities have the potential to affect the Baltic Sea negatively through release of nutrients, physical disturbance, and extraction of resources. A Baltic wide assessment of the impact of recreational activities is missing but information from some countries gives an indication of the extent of the pressure.

6.4.1 Recreational activities and their impact on the Baltic Sea

All coastal areas visited for recreational purposes are subject to littering and direct physical disturbance such as trampling which may effect the submerged vegetation in beach areas. A more continuous impact stems from summerhouses, which contribute to an unproportionally large nutrient release to the Baltic since many summerhouses are not connected to municipal sewage treatment plants. The development of jetties in summerhouse areas also contributes to fragmentation of shallow water habitats.

In addition, boats and associated activities such as fishing are the cause of multiple impacts on the Baltic environment. An overwhelming majority of recreational boats in the Baltic Sea area belong to Denmark, Finland and Sweden; in Denmark the number of privately owned boats used along the Baltic Sea coast are 400 000, in Finland roughly the same, and in Sweden 450 000. This estimate includes vessels ranging from rowboats to motor- and sailing boats with overnight capacity (DEPA 2002, SCB 2004). In Estonia and Latvia the number of leisure boats are about 14 500 and 7 300 respectively.

Impacts of boating

In Finland it is forbidden to release toilet waste within territorial waters since 2005. Private boat owners are thus obliged to collect toilet waste onboard and deliver the waste to reception facilities in Finnish harbours. In many cases however, toilet waste from recreational boats is released directly into the sea. This is the case for an estimated 60% of Swedish boats that have onboard toilets (SCB 2004). The toilet waste poses a hygienic risk when disposed in coastal areas and is also a source of nutrients. In the Stockholm archipelago it is estimated that 4.5 tonnes nitrogen and 1.1 tonnes phosphorus is released to the water as toilet waste every summer (SEPA 2007). On a Baltic wide scale recreational boats have been estimated to contribute within the range of 30-190 tonnes nitrogen and 4-28 tonnes of phosphorus per year (DEPA 2002).

High boating activity also effects the aquatic vegetation in the near shore area. Shallow bays that are exposed to traffic by recreational boats and small ferryboats show a lower areal vegetation coverage and species richness compared to reference areas (Eriksson et al. 2004). The fish communities also differ between these areas; fish dependent on aquatic vegetation during early life stages appears less common in the areas affected by boating (Sandström et al. 2005).

The adverse effect of antifouling paints containing zinc, copper and organic tin-compounds on aquatic organisms are well known. Bans for use of tributyltin (TBT) for small boats (<25 meters) in the Baltic Sea area began twenty years ago. TBT is however still found in high concentrations in sediments close to small guest- and natural harbours along the Swedish coast of the central Baltic proper and the whole Finnish coast (Nordfeldt 2007, Vahanne et al. 2007). Since no commercial vessels traffic these areas the results indicate that past used by recreational boats still is a significant contributor to TBT in the marine environment.

Gas emission from motorised boats is an additional problem, in particular regarding carbon monoxide (CO) and hydrocarbon emissions (HC). This is because a large fraction of recreational boats have two-stroke engines with inefficient fuel combustion. Along the Finnish coast recreational boats accounted for more than 70% of CO and HC emission from all boat and ship traffic in 2000 (Wahlström et al. 2006). As much as 20-30% of the gas is also released directly into the water.

Motorised leisure boats also disturbe marine mammals and waterfowls through generation of noise, and collisions between mammals and leisure boats do occur.

The boating activity is supported by a considerable number of marinas that contribute to fragmentation of the coastal zone and that are associated with the negative impacts of dredging during construction. Along the

German Baltic coast there are 250 marinas and several more in planning (Fröhle 2008) while in Finland the number is about 530, including Åland. Along the Swedish coast, the Kattegat area include, the number of guest harbour alone is 290, i.e. harbours offering berths to visiting recreational boats. In Estonia and Latvia the number of yacht harbours are around 50 and 20 respectively (Estonian Maritime Administration, (Anonymous 2006). With a rapidly developing tourism sector the demand for yacht harbours is increasing in both countries: in Estonia incoming yachts doubled during the last 10 years and in Latvia visiting yachts increased by 70% in the period 2001-2005 (Anonymous 2006). Also in Poland there are plans to enlarge existing as well as building new marinas to meet a growing number of tourists arriving by boat (pers comm. E. Andrulewicz).

Impacts of recreational fishing

In 2006 about 330 000 Swedes and 458 000 Finns were engaged in recreational fishing along the Baltic Sea coast and archipelago areas (FGFRI 2007b, SNBF 2008). The same year 225 000 fishing licences were issued in Denmark. In Estonia, about 2 500 licences allowing fishing by gillnet and longline were issued to leisure fishermen operating in marine waters in 2007 while the number of persons involved in angling at sea was estimated at 7000.

The landings in recreational fisheries are generally low compared to the commercial fisheries but may still have an impact on declining stocks, in particular on local coastal stocks. Pike and perch are the most common species caught in recreational fishing in both Sweden and Finland. In 2006 the landings of pike and perch were many-fold higher than the relatively limited commercial fishery of these species (Figure 6.4.1). The recreational catch of cod along the Swedish coast of the Baltic Sea, the Kattegat included, made up 6% (729 tonnes) of the commercial landings. In Estonia the licensed fishing for the two most important target fish in 2007 was estimated at 43 tonnes of flounder and 11 tonnes of perch.

6.4.2 International frameworks regulating recreational activities

Recreational activities are almost exclusively regulated at the national level. An exception is legislation related to use of antifouling chemical: since 2003 the application of TBT (tributyltin) antifouling is forbidden for all vessels in all EU countries ((EC) No 782/2003). Use of antifouling paints containing TBT was however banned for small boats (<25m) in several countries in the Baltic Sea area already in the late 1980s/early 1990s.

Two EU directives are directly related to recreational boats; Directive 94/25/EC which covers design and construction aspects and Directive 2003/44/EC which amends the former directive by including limit values for exhaust and sound emissions for motor boats. The limit values apply to engines and craft built after 2005 and 2006 depending on motor type.

HELCOM has two recommendations that directly link to recreational activities. Recommendation 22/1 stipulates that all vessels that have a toilet, including pleasure craft, should have a toilet waste retention system that can be emptied into port reception facilities. In the principles outlined for sustainable tourism in recommendation 21/3, the guidelines stipulates that “Leisure activities should be managed, particularly in the protected areas, in a way that they fulfil the requirements of biological and landscape diversity and soil conservation”.

6.4.3 Conclusions

Compared to other pressures such as land based nutrient input and commercial fisheries, recreational activities are still minor contributors to the negative impact on the Baltic marine environment. This is not to say that the contribution is insignificant. Locally boating activities can have a negative impact on important habitats, in particular in the near coastal zone.

The increasing standard of living in the Baltic region will likely be followed by increasing number of privately owned boats. In Estonia and Latvia there is also a rapid increase in the tourism sector (Anonymous 2006). As the recreational boats increase so does the demand for marinas and space in the coastal zone. All indications point to recreational activities as an increasing pressure in the Baltic Sea area.

6.4 FIGURES

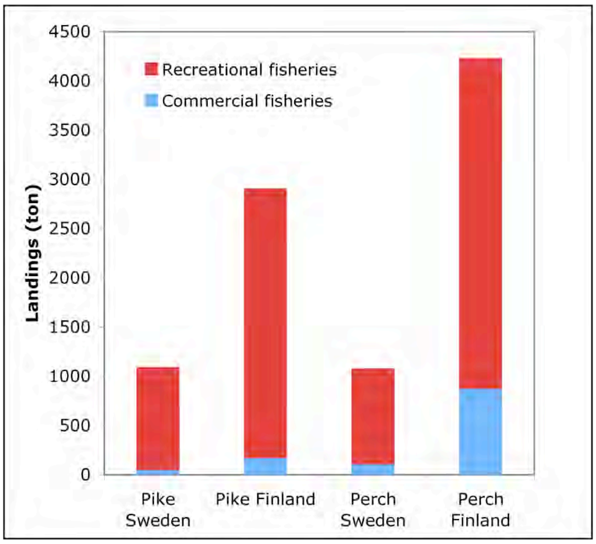


Figure 6.4.1. Recreational and commercial fisheries of pike and perch in Sweden and Finland, year 2006. Sources: Swedish Board of Fisheries (SNBF 2008), Official statistics on landings in the Swedish commercial fisheries, URL: www.fiskeriverket.se, Finnish Game and Fisheries Research Institute (FGFRI 2007b, a)

6.5 Eutrophication

The effects of nutrient enrichment, also known as eutrophication, are perhaps the most significant threat to the marine environment of the Baltic Sea. In short, eutrophication means 'well nourished', but it has now for more than three decades been acknowledged that too large amounts of nutrients, e.g. nitrogen (N), phosphorus (P), and sometimes organic matter (C), can result in a series of undesirable effects in ecosystem structure and functioning.

The Baltic Sea Action Plan identified eutrophication as one of the four main issues to be addressed in order to improve the health of the Baltic Sea environment. The Action Plan set a strategic goal related to eutrophication: *"Baltic Sea unaffected by eutrophication"*. The vision of good environmental status of the Baltic Sea has been split down in to five eutrophication related ecological objectives: *"Concentrations of nutrients close to natural levels"*, *"Clear water"*, *"Natural level of algal blooms"*, *"Natural distribution and occurrence of plants and animals"*, and *"Natural oxygen levels"*. In addition, HELCOM countries agreed on provisional country-wise nutrient reduction targets and decided to take action to diminish nutrient inputs to the Baltic Sea not later than 2016.

HELCOM has recently published an integrated thematic assessment of eutrophication in the Baltic Sea which gives an in-depth overview of the problem (HELCOM 2009). Hence, the issue is only briefly covered here.

6.5.1 Causes of eutrophication

Because of the shallow and strongly stratified basin and long residence time of water, the Baltic Sea is highly sensitive to eutrophication. The external inputs of nutrients to the Baltic Sea come from the drainage basin and deposition from the atmosphere, but internal inputs of phosphorus from the sediments and fixation of atmospheric nitrogen by cyanobacteria can also be substantial. Excess nutrients originate particularly from municipal and rural human sources, from agricultural activities, as well as from nitrogen emissions of transportation and combustion activities and subsequent deposition onto the Baltic Sea.

High nutrient inputs in combination with long residence times mean that nutrients discharged to the sea stay in the sea for long time, even decades, before being flushed out of the Baltic Sea into the Skagerrak and North Sea surface waters or being buried into the sediments.

6.5.2 Eutrophication status of the Baltic Sea

The eutrophication status of the Baltic Sea in 2001-2006 was extensively covered, analysed and evaluated in the HELCOM integrated thematic assessment of eutrophication (HELCOM 2009). The results of the report are clear, the over-all eutrophication status of the Baltic Sea is unacceptable. Only 13 of the areas assessed in the report were classified as being "eutrophication non-problem areas", while 180 areas were classified as "eutrophication problem areas". The non-problem areas were found in the Gulf of Bothnia and in the Kattegat (Figure 6.5.1). The overall picture, however, is not completely dark since nutrient inputs to the Baltic seem to have decreased slightly between 1995-2000 and 2001-2006. In addition, in most sub-basins the highest surface concentrations of nutrients were observed in the 1980s and in many of the basins there are encouraging signs of decreasing surface nutrient concentrations during the past two decennia.

6.5.3 Effects of eutrophication on biodiversity

Eutrophication has direct as well as indirect negative impacts on biodiversity. The manifestations of a large-scale eutrophication problem are well known in most parts of the Baltic Sea, e.g. murky water due to blooms of planktonic algae, mats of macroalgae at shores, reduced distribution of benthic habitats such as eelgrass meadows, or oxygen depletion resulting in the death of benthic animals and fish.

Abundance of phytoplankton reflects productivity of the planktonic ecosystem. Phytoplankton blooms in spring and summer are periods of naturally high production supplying energy to the ecosystem. Excessive blooms and especially blooms of harmful algae, like cyanobacteria or certain haptophytes, are however a major problem in the Baltic Sea. Harmful algal blooms represent periods of reduced biodiversity and the toxins produced by algae are a potential and actual threat to other organisms.

Another important effect is that increased biomass of phytoplankton and other organisms in water result in increased turbidity and reduced light penetration through the water column to the sea floor. Decreased light hampers the growth of higher plants and macroalgae such as eelgrass and bladderwrack.

Extensive seagrass meadows and perennial macroalgal communities harbour the highest biodiversity in coastal, shallow water ecosystem. In the HELCOM red list of marine and coastal biotopes, eutrophication is mentioned as the worst threat next to general pollution affecting the marine and coastal biotopes and biotope complexes of the Baltic Sea (HELCOM 1998).

Eutrophication has complex effects on the state of submerged aquatic vegetation (SAV): (1) reduced light penetration through water column, caused by increased pelagic production, limits the depth penetration of SAV species, (2) increased sedimentation can prevent the settlement of new specimens on the seafloor and reduces the amount of suitable substrate to be colonised by perennial species on all kind of substrates, (3) the excess of nutrients during the whole vegetation period often favours opportunistic species with short life cycles and fast development over the perennial species with lower productivity causing a shift in community composition.

The composition of animal communities living on the sea floor of the Baltic Sea reflects the conditions of the environment. With the eutrophication process, broad-scale changes in the composition of the communities usually accompany the increasing organic enrichment of the sediments. At advanced stages of eutrophication oxygen depletion becomes common. In many areas of the Baltic the seafloor animals are exposed to widespread oxygen depletion or complete anoxia. As a result, biodiversity of the sea floor is reduced or animal communities are completely destroyed if anoxia is long lasting.

The effects of eutrophication are also manifested in fish communities. In principle, eutrophication can be considered as having been a beneficial process to fisheries due to increased fish production. It has affected fish stocks selectively, for example increased turbidity of waters has favoured percids and cyprinids and negatively affected salmonids which prefer clear water. Eutrophication has affected also other aspects of fish, such as lost shelter or spawning ground function caused by reduced macro vegetation coverage.

6.5.4 Conclusions

Eutrophication is a Baltic-wide problem of serious concern which has a negative effect on most components of biodiversity in the Baltic Sea. It reduces water quality and extends to nearly all areas of the Baltic Sea, including the marine protected areas. This implies that spatial protection measures can not result in a favourable conservation status of biodiversity unless eutrophication is reduced to a level causing no disturbance.

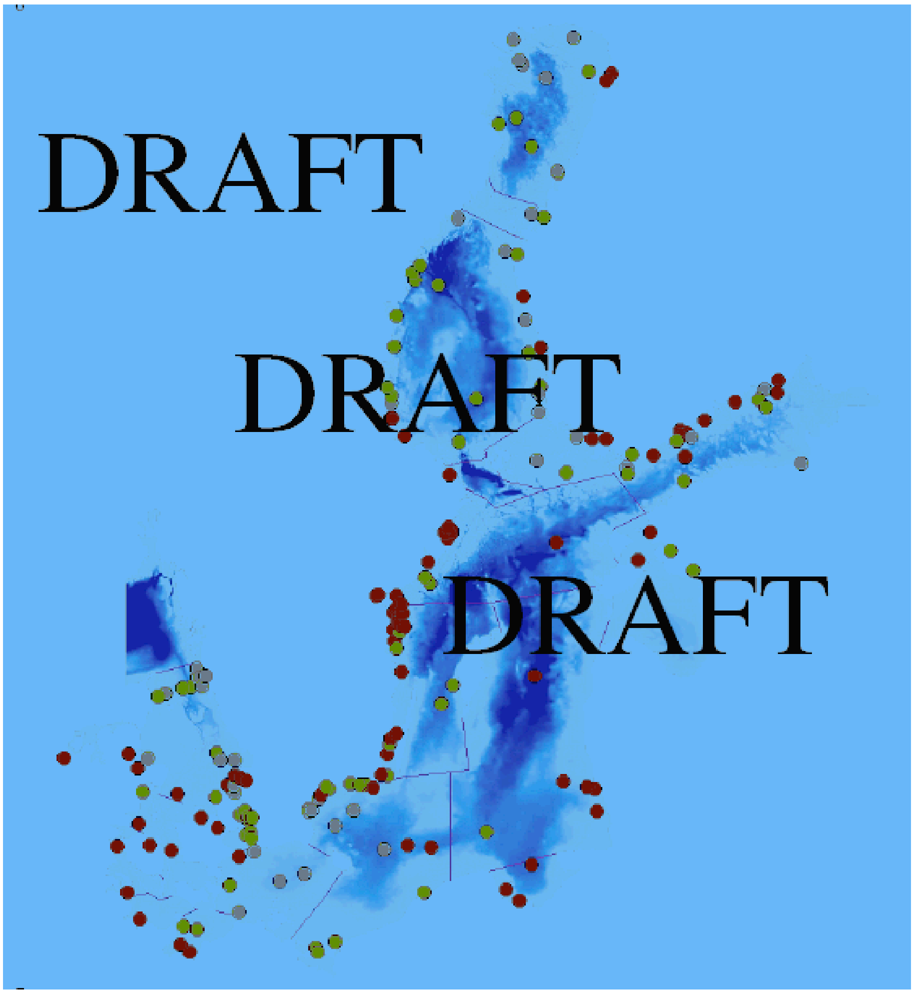


Figure 6.5.1. Classification of eutrophication status based on 193 areas. Green = good status, yellow = moderate status, orange = poor status, and red = bad status. Good status is equivalent to ‘eutrophication non problem area’, while moderate, poor and bad is equivalent to ‘eutrophication problem areas’ (see HELCOM 2009 for details).

6.6 Hazardous substances

The Baltic Sea is particularly sensitive to persistent, toxic and bioaccumulative (PBT) substances because of its special abiotic characteristics and the fact that many of the inhabiting species are not originally adapted to a brackish water environment.

Adverse effects caused by hazardous substances on biodiversity have commonly included impaired general health status of animals, impaired reproduction and increased pollutant levels in fish consumed by humans. Effects on plants and invertebrates may be less pronounced, since hazardous substances tend to accumulate over time and through the food chain to species at higher trophic levels. Once released into the Baltic Sea, hazardous substances can remain in the marine environment for very long periods and can accumulate in the marine food web to levels which are toxic to marine organisms.

The loads of some hazardous substances to the Baltic Sea have decreased considerably over the past 20–30 years but problems still persist. With the increased use of chemicals and the development of new synthetic chemical compounds, concentrations of certain new substances have increased in the marine environment.

One of the four segments of the Baltic Sea Action Plan is devoted to hazardous substances (HELCOM 2007a). With the hazardous substances segment the HELCOM Contracting Parties committed themselves to numerous actions to diminish pollution by hazardous substances. HELCOM has agreed to focus its work on two heavy metals, cadmium and mercury, and on nine organic substances or substance groups (Table 6.6.1) which are included in the Baltic Sea Action Plan (HELCOM 2007a).

6.6.1 Sources and inputs to the Baltic Sea

The main pathways of hazardous substances to the marine environment are atmospheric deposition and industrial and municipal wastewaters which are discharged directly to the Baltic or transported via rivers. Hazardous substances from industries are emitted from all stages of the production chain.

Heavy metals

Significant amounts of atmospherically transported heavy metals originate from distant sources outside the Baltic Sea catchment. Also a large part of the waterborne inputs of heavy metals originate from non-HELCOM countries of the catchment area (HELCOM 2007b).

Annual emissions of heavy metals from HELCOM countries to air have decreased during the period from 1990 to 2005 by 45% for cadmium, 46% for mercury, and 86% for lead (Gusev 2007a) (Figure 6.6.1). Since the mid-1990s also riverine heavy metal loads, especially those of cadmium and lead, have decreased in several countries (Knuuttila 2007).

The total atmospheric deposition of heavy metals into the Baltic Sea during 2005 was 5.3 tonnes of cadmium, 3 tonnes of mercury and about 251 tonnes of lead (Gusev 2007b). The Belt Sea and Kattegat were the sub-basins receiving the highest amounts of heavy metal deposition. The reported riverine loads, including direct discharges from coastal areas, to the Baltic Sea in 2005 amounted to 55 tonnes of cadmium, 13.6 tonnes of mercury and 473 tonnes of lead. The riverine inputs of cadmium and lead into the Gulf of Finland were the highest of all basins, while the Baltic Proper received the highest inputs of mercury.

Organic pollutants

The main source or pathway to the Baltic marine environment of TBT and TPhT is their anti-fouling use in ship hulls and subsequent direct release to sea water. On the other hand, the main pathways of pentaBDE, octaBDE and decaBDE, HBCDD, PFOS, PFOA, SCCP and MCCP to the Baltic Sea are via municipal and industrial waste waters and the atmosphere. Municipal and industrial waste waters are also the main sources of NP, NPE, OP and OPE. The main pathways of endosulfan are via rivers receiving losses from agricultural land and from atmospheric deposition due to the application of agricultural pesticides containing endosulfan. Discharges from landfills and via storm water can be significant for some of the substances mentioned above (HELCOM 2007a, 2007c, HELCOM, in prep.).

Total annual atmospheric deposition of PCDD/Fs to the surface of the Baltic Sea has decreased by 50% during the period 1990-2005. At the sub-basin level the most significant decrease in PCDD/F deposition has been observed in the Belt Sea (40%) and the Gulf of Riga (39%). Currently, the highest levels of PCDD/F deposition over the Baltic Sea can be noted for the Belt Sea and the lowest deposition fluxes for the Gulf of Bothnia (Gusev 2007c).

6.6.2 Occurrence and impacts of hazardous substances on the marine environment

For many organic contaminants, a full assessment of their levels and effects in Baltic marine environment is not possible due to the lack of monitoring and eco-toxicological data.

Although no direct, dramatic mass mortalities after exposure to contaminants may occur, reduced fitness of organisms due to physiological disturbances and increased energy costs e.g. related to detoxification processes, synthesis of chaperone proteins and maintenance of other energy consuming protective functions to cope with chemical stress, may have significant long-term structuring effects on population and community scales.

PCBs and DDTs

Amongst the most well-known success stories for the Baltic Sea nature conservation are the recoveries of seal and predatory bird populations from the declines caused by hazardous chemicals. During the 1970s, the reproductive health of seals and predatory birds was observed to be severely impacted as a result of pollution by PCBs (polychlorinated biphenyls) and DDT (dichloro diphenyl trichloroethane). Uterine damage is now less common and also for ringed seals the situation has improved simultaneously with decreasing concentrations of contaminants (Helle 1981, Ministry of Agriculture and Forestry 2007). Intestinal ulcers, on the other hand, are nowadays common, even in young grey seal individuals (HELCOM 2007c).

Decreasing reproductive success of top predators is an indicator of detrimental effects of accumulating hazardous substances. The shell thickness of common guillemot (*Uria aalge*) eggs from Stora Karlsö in the central Baltic Proper has been monitored in Sweden since the end of the 1960s. Guillemot eggshell thickness has increased in the 1990s and the shell thickness is back to levels recorded prior to the 1940s (Figure 6.6.2). The thin eggshells observed during the 1960s were attributed to the severe DDT pollution during that period. Similar impacts and recovery from DDT and other substances have been observed in Swedish time series of white-tailed eagle (*Haliaeetus albicilla*) brood size and nesting success (HELCOM 2002).

PCB levels in herring muscle in Swedish coastal areas from Kattegat to the Bothnian Bay have decreased significantly during the time period 1978/80-2005. The levels are still significantly higher in the Baltic Proper and in the southern Bothnian Sea compared to the Kattegat and the Skagerrak. Two cod liver time-series (1980-2004/05) from the southeast of Gotland and Kattegat also show significant decreasing trends of PCB (Bignert et al. 2007c).

Heavy metals and dioxins

Decreasing trends, or no trend at all, have been observed for mercury concentrations in herring in Swedish and Finnish coastal waters. During the recent years, cadmium levels in herring and cod have been decreasing in some Swedish coastal areas. However, the levels have not yet reached those of the beginning of the 1980s (Bignert et al. 2007a, ICES 2007). Among the positive signs is the clear decrease in lead levels in biota (e.g. herring and perch liver) in most Baltic Sea areas (Bignert et al. 2007b, ICES 2007).

Concentrations of dioxins in the Baltic marine ecosystem declined during the 1970s and 1980s but this decrease leveled off in the 1990s and fatty Baltic fish (e.g. herring and salmon) still have high levels of dioxin contamination (HELCOM 2004).

Organotin compounds

The occurrence of organotin compounds is widespread in the Baltic Sea marine environment (water, biota and bottom sediment), particularly near harbours and shipyards (Table 6.6.2, HELCOM in prep.). Elevated levels occur also near ship routes and at the disposal sites for dredged material. The current levels of the most toxic triorganotin compounds, TBT and TPhT, pose a risk to the marine environment and especially to organisms at the lower trophic levels of the food web, such as sediment-dwelling organisms. Imposex and intersex reproductive and gender disorders induced by TBT are widespread in the Danish Straits and coastal areas (Strand & Jacobsen 2002, 2005, HELCOM 2003). High butyltin concentrations have also been found in sediments and biota from marinas e.g. in the Gulf of Gdansk (Falandysz et al. 2002, Albalat et al. 2002) with potentially similar effects on local populations and thus species' distribution.

The most sensitive reaction of mammals to TBT is linked to effects on the immune system. It is supposed that TBT could increase the susceptibility of mammals to diseases such as microbial infection. It is possible that TBT acts in a synergistic way with other immune toxicants such as PCBs. The potential adverse effects of contaminants (e.g. PCBs and heavy metals) on the immune system and the health status of marine mammals are still under some debate (Beineke et al. 2005).

PFOS & HBCDD

There are indications that PFOS may be threatening Baltic Sea top predators, such as seals and predatory birds via secondary poisoning (HELCOM, in prep.). Moreover, the level of HBCDD in guillemot egg shows a significant increase of about 3% per year (Figure 6.6.3). However, no trend has been detected for HBCDD in herring muscle during the monitored time period, 1999-2005, although HBCDD levels in fish of the Baltic Sea are in general low and always lower than the estimated Predicted No-Effect Concentration (PNEC) level (HELCOM, in prep.).

6.6.3 Major international frameworks regulating hazardous substances

The two main global agreements on hazardous substances are the Stockholm Convention on Persistent Organic Pollutants and the Protocol on Persistent Organic Pollutants to the UNECE Convention on Long Range Transboundary Air Pollution. The Anti-fouling Convention of IMO concerns the use of organotin compounds (e.g. TBT and TPhT) and the application of TBT and TPhT has been banned in anti-fouling systems since 2003 and the removal or coating of hulls or other surfaces containing TBT or TPhT has been required since 2008.

There is EU legislation concerning hazardous substances, such as REACH (2006/1907/EC), Integrated Pollution Prevention and Control Directive (96/61/EC) and the Water Framework Directive's (60/2000/EC) list of priority substances (2455/2001/EC). In addition, many HELCOM Recommendations concern limitation of chemical pollution, including Recommendation 19/5 on the HELCOM Strategy for hazardous substances.

6.6.4 Conclusions

There are encouraging signs of decreasing concentrations and impacts on biota of certain hazardous substances for which there exists long-term monitoring data. At the same time, there are increasing concerns about the occurrence and negative biological effects of substances such as TBT/TPhT, PFOS, dioxins, furans and dioxin-like PCBs. The effects of specific substances on Baltic marine environment are difficult to estimate due to lack of eco-toxicological information or lack of monitoring data concerning both the occurrence of substances and biological effects in the Baltic marine environment.

Bearing in mind the complex hydrographic conditions, and the fact that most of the Baltic Sea organisms live at the edge of their physiological tolerance range, anthropogenic chemical pollution has to be seen as a further stress factor acting upon the Baltic Sea ecosystem. Only during the recent decade we have started to gain advanced understanding on how multiple stressors (e.g. salinity, temperature, hypoxia and chemical pollution) in combination may affect biota and thus biodiversity.

6.6 TABLES

Table 6.6.1. Substances or substance groups of specific concern to the Baltic Sea and included in the HELCOM Baltic Sea Action Plan.

1. Dioxins (PCDD), furans (PCDF) & dioxin-like polychlorinated biphenyls
2a. Tributyltin compounds (TBT)
2b. Triphenyltin compounds (TPhT)
3a. Pentabromodiphenyl ether (pentaBDE)
3b. Octabromodiphenyl ether (octaBDE)
3c. Decabromodiphenyl ether (decaBDE)
4a. Perfluorooctane sulfonate (PFOS)
4b. Perfluorooctanoic acid (PFOA)
5. Hexabromocyclododecane (HBCDD)
6a. Nonylphenols (NP)
6b. Nonylphenol ethoxylates (NPE)
7a. Octylphenols (OP)
7b. Octylphenol ethoxylates (OPE)
8a. Short-chain chlorinated paraffins (SCCP or chloroalkanes, C_{10-13})
8b. Medium-chain chlorinated paraffins (MCCP or chloroalkanes, C_{14-17})
9. Endosulfan
10. Mercury
11. Cadmium

Table 6.6.2. TBT and TPhT concentrations in Baltic Sea water. Predicted No-Effect Concentration (PNEC) has been presented for comparison purposes (HELCOM, in prep.).

Area	Sea water (ng/l as TBT or TPhT)
Denmark, Sound & Kattegat [1]	<2.4 TBT
Finland, Gulf of Finland, dredging sites [2]	<1-13.6 TBT / TPhT not detected (<1)
Lithuania, Southern Baltic Proper, harbour area [3]	12 TBT / TPhT not detected (<1)
Sweden, Bothnian Sea [4]	mean 11 TBT / mean 12 TPhT
Sweden, Northern Baltic Proper [4]	mean 2.2 TBT / TPhT not detected
Sweden, Kattegat [4]	0.24-2.2 TBT / 0.03-2.4 TPhT
Sweden, Kattegat [4]	year 2001: 0.24-1.5 TBT / max 0.68 TPhT year 1987: 29-634 TBT
PNEC	AA 0.2 TBT* / MAC 1.5 TBT* / 1.0 TPhT**

[1] one bay in Sound and one "fjord" in Kattegat, [2] six sites in the vicinity of harbour under construction (dredging), 8 samplings in 2005, [3] one harbour area sampled in 2006, [4] sampled in 2001, * proposed EU Environmental Quality Standard for chronic effects (AA-EQS, annual average value) and for short-term eco-toxic effects (MAC-EQS, maximum allowable concentration) in inland and other surface waters for TBT, ** Estimated PNEC for TPhT in marine waters.

6.6 FIGURES

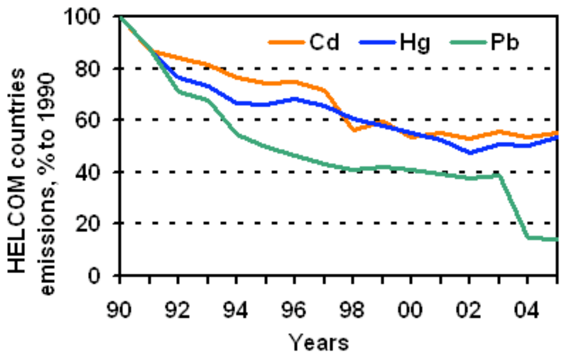


Figure 6.6.1. Total annual emissions of cadmium (Cd), mercury (Hg), and lead (Pb) to air from HELCOM countries in period 1990-2005 (% of 1990, Gusev 2007a).

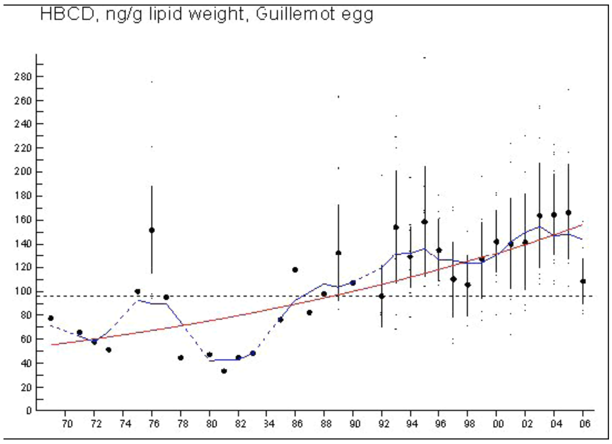


Figure 6.6.3. Temporal trends of HBCDD concentration (ng/g lipid weight) in guillemot egg in 1969-2005 (Bignert et al. 2007d).

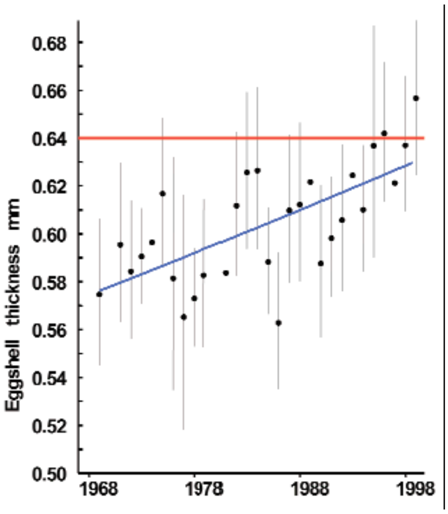


Figure 6.6.2. Temporal trend in the thickness of common guillemot (*Uria aalge*) eggshells collected in Stora Karlsö in the central Baltic Proper. The solid red line indicates the thickness prior to 1940 (HELCOM 2002).

6.7 Alien species

The Baltic is a sea of invaders as most animal and plant species here are postglacial immigrants. In contrast to distribution by natural spreading mechanisms, alien species are defined as "species or lower taxa occurring outside of their natural range (past or present) and dispersal potential..." (IUCN 2002). Some alien species have turned out to become invasive, i.e., an alien whose population undergoes an exponential growth stage and rapidly extends its range (Occhipinti-Ambrogi & Galil 2004).

Alien species act as modifiers of biodiversity and biogeography. Due to this, the characteristics and integrity of the Baltic developed since the last Ice Age are threatened, and the Sea is subject to worldwide homogenisation of the aquatic flora and fauna (Leppäkoski & Olenin 2001). Recent establishment of a number of alien species populations can be considered as biocontamination (Arbačiauskas et al. 2008) of the indigenous Baltic ecosystem since the invaders have caused alteration in taxonomic structure of the invaded communities. In the Baltic these changes are restricted mainly to the family and genus level. For instance, more than every second established alien species included in the Baltic Sea Alien Species Database (2008) belongs to genera that are not represented among the native flora and fauna of the Sea. In the inner Baltic, some newcomers contribute to taxonomic diversity at higher levels: the alien barnacle *Balanus improvisus* is the only representative of its order Thoracica. Similarly, the only species belonging to gambarid decapod crayfish (*Orconectes limosus* and *O. virilis*) and to mud crabs (Decapoda, Xanthidae (*Rhithropanopeus harrisii*) as well as the Chinese mitten crab *Eriocheir sinensis* (family Grapsidae) are invaders in the Baltic. Only one native comb jelly species (*Pleurobrachia pileus*) represents the phylum Ctenophora; in addition an introduced species (*Mnemiopsis leidyi*) has established since 2006. Further, only one native cumacean crustacean (*Diastylis rathkei*) was present prior the introduction of *Stenocuma graciloides*, first found in 2004.

6.7.1 Trends and impacts

Trends

Since the early 1800s, about 120 alien species have been recorded in the Baltic Sea (the Kattegat included; Figure 6.7.1; Box 6.7.1). The invasion rate for the region was approximately 1.3 new alien species every year over the period 1961-2007 (derived from Baltic Sea Alien Species Database 2008). Since World War II, 81 new alien species have been recorded in the Baltic; 35 species of them have been ship-assisted. Eight new species have been observed during the past five years only. Many of the old invaders are currently widely spread and occur in high densities in the coastal Baltic Sea e.g. the barnacle *Balanus improvisus* and the bivalve *Dreissena polymorpha*, but also some of the most recent invaders have shown a very rapid expansion. One of the most well documented invasion is that of the benthic bristle worm *Marenzelleria* spp. that currently occurs in the entire Baltic Sea and has become common in many soft bottom habitats and even a dominant species in bottom communities in only about ten years since its first occurrence (Zettler 1996, Cederwall et al. 1999, Perus & Bonsdorff 2004) (Figure 6.7.2). Recent genetic studies have also revealed that the invasion is made by three different species (*M. viridis*, *M. neglecta* and *M. arctia*) that obviously are still expanding (Blank et al. 2008). Other recent alien species with a rapid invasion over large sea areas in the Baltic include pelagic species like the fishhook water flea *Cercopagis pengoi* and the American comb jelly *Mnemiopsis leidyi*.

In the Baltic and elsewhere, the increased invasion rate (Figure 6.7.1, Box 6.7.2) can be related to several factors: (i) increased number and size of ships, (ii) increased speed of ships, resulting in better survival of organisms during the voyage, (iii) use of separate tanks instead of cargo tanks for ballast water (less polluted ballast water), (iv) successive opening of new trade routes in the post-war era, (v) opening of canals, supporting both natural and human-assisted migration along inland waterways, and (vi) intentional introductions for aquaculture and stocking purposes. In the former Soviet Union, tens of Ponto-Caspian crustacean species were transplanted into the Baltic catchment as potential prey items to stimulate fish production in lakes and water reservoirs in the 1950s-1970s. Some of these species have expanded their range along rivers to coastal waters (Ojaveer et al. 2002).

In the Baltic Sea, dispersal of alien species has been rapid and effective, as demonstrated by some of the most successful invaders. The minimum rates of secondary, within-basin spread were estimated for some ship-mediated animals: the American barnacle *Balanus improvisus* 30 km per year; the North American bristle worm

Marenzelleria sp. 170-480 km per year, and the mud snail *Potamopyrgus antipodarum*, native to New Zealand, 20-50 km per year (Leppäkoski & Olenin 2000).

Origin of the invaders

The world wide transport of alien species is reflected in the origin of species, the most important donor areas for the Baltic Sea being North America and the Black and Caspian Sea region (Figure 6.7.3). Brackish-water seas are especially open to species introductions for several reasons. In the Baltic Sea, horizontal and vertical gradients (salinity range from < 2 to about 20 PSU) allow for a greater range of opportunities for alien species of different origin (Paavola et al. 2005). Invasion pressure is two-directional, through both oceans and seas and inland waterways; several freshwater invasion corridors open into the Baltic via rivers and canals from southeast to southern Baltic and the Gulf of Finland. Further, important ports are located worldwide in brackish reaches of estuaries. Hence the brackish fauna and flora stand a better chance of being loaded with ballast water. Generally, most brackish-water species are tolerant to wide salinity and temperature ranges, resulting in better survival in ballast water compared to strictly fresh or marine water organisms. In brackish waters, ratio for non-native to native species may be as high as 1:5 (in estuaries or lagoons) compared with 1:20 at open coasts and 1:40 in European marine waters (Reise et al. 2006).

Ecological impacts

Alien species affect the structural and functional properties of ecosystems at local (Figure 6.7.2), regional, and basin-wide scales. Several invaders represent a new functional group in the invaded community and differ substantially from natives in life form and efficiency of resource utilisation (Table 6.7.1).

In many cases, the ecological impacts of alien species on the Baltic Sea ecosystem have been more or less unobservable or they are poorly understood due to lack of focused studies. However, (1) increasing spread increases the risk that native species or habitats of high conservation value will be impacted, and (2) an established population may adapt physiologically and ecologically to the Baltic environment, increasing the risk of ecological and environmental impacts. These are due to changes in resource competition (food, space), changes in habitat (physical and biological), changes in the trophic web, toxins produced by alien algal species, introduction of new disease agents and parasites (or introduction of a species being a missing link as host in the life cycle of a parasite), genetic effects on native species (hybridisation, loss of native genotypes), and as a worst case scenario, extinction or drastic reduction of native species. In this way, it is possible to distinguish between types of impact but not to assess scales of impact; much remains to be explored in this field of invasion biology.

In the most heavily invaded coastal lagoons of the southern Baltic, several food chains and even major parts of sea-bottom communities can be based upon introduced species (Leppäkoski et al. 2002). In these areas, the impacts related to bottom-living alien animals are relatively well understood (Table 6.7.1) while there is much to learn about the ecological roles of planktonic invaders, such as the fishhook water flea (*Cercopagis pengoi*; first found in 1992) and the highly invasive American comb jelly (*Mnemiopsis leidyi*, first found in 2006). Further spread, biology and feeding ecology (especially their potential impacts on the Baltic food web) of these species must be monitored carefully.

Every single species establishment in a novel region and ecosystem opens new opportunities for ecological research. These most often unintentional ”transplantation experiments” can be used for the studies of concepts such as adaptive strategies, niche dimensions, interspecific relationships, dispersal mechanisms etc (Leppäkoski 2002).

Socio-economic impacts

The newcomers affect the ecosystem services available for humans, such as primary production, degradation capacity, fish production, recreational uses and amenities. From this point of view, the most unwanted alien invaders in the Baltic are (1) fishery disrupters, (2) fouling organisms and (3) boring species. Impacts of fishery disrupters are expected but not proven yet. The American comb jelly *Mnemiopsis leidyi*, first found in 2006 in the Baltic Sea, is now abundant up to the Bothnian Sea. This species contributed to the collapse of Black Sea commercial fisheries in the late 1980s, and a similar collapse in the Caspian Sea in the early 2000s. Fouling organisms like the Ponto-Caspian water flea *Cercopagis pengoi* causes clogging of gill nets. The zebra mussel *Dreissena polymorpha* affects cooling systems and fouls beaches with its sharp shells, and the barnacle *Balanus improvisus* and the colonial hydroid *Cordylophora caspia* are sessile biofoulers common on boat hulls and underwater constructions. The boring shipworm *Teredo navalis* has expanded its range in the southern Baltic and threatens e.g. the numerous and well preserved historical wrecks and other wooden constructions.

The recent findings (in the early 2000s) of dense populations of Conrad’s false mussel, *Mytilopsis leucophaeata*, in the cooling water discharge areas off Finnish nuclear power plants must be taken seriously. This species has its original distribution in the subtropical and temperate Gulf of Mexico area and is tolerant to the entire salinity range found in the Baltic Sea. In Western Europe it has become a serious biofouling organism in cooling water systems with economical impacts for water dependent industries (Laine et al. 2006). The species may benefit from the future expected climate change associated temperature increase.

Some of the water-living alien species are beneficial (e.g., in the Baltic, the North American rainbow trout in aquaculture). Perhaps more importantly, many non-native species and their larvae play an important role in the coastal food webs, serving as food source for commercially important native species.

6.7.2 Major international frameworks that address invasive species

Eradication of established water-living alien species is a hopeless task. Prevention of further arrivals is the only way to go and thus a crucial issue for the biosecurity strategy to be developed for the Baltic Sea area. Ships are currently the most important vectors for alien species. The IMO Ballast Water Convention (adopted in 2004) will be the global instrument to regulate the management, treatment and release of ballast water.

A roadmap towards implementation of the Convention in the HELCOM area was included in the Baltic Sea Action Plan (BSAP) in November 2007. One of the targets of the BSAP is “To prevent adverse alterations of the ecosystem by minimising, to the extent possible, new introductions of non-indigenous species”. While intentional introductions into inland and coastal waters are largely banned in all riparian countries, shipping is currently the most common vector for alien invasive species. In a recent report to HELCOM (Leppäkoski & Gollasch 2006), a number of actions were suggested to reduce the risk from ship-mediated species introductions: identify most important source areas and pathways leading to unintentional introductions, establish an early warning system rapidly reporting on new findings of alien species, develop an online decision support system to assist port authorities and ships' crews in ballast water management, introduce a ballast water reporting system, and elaborate a common structured procedure for species-specific risk assessment.

6.7.3 Conclusions

Alien species are a major threat to indigenous biodiversity leading to restructuring of communities, which formerly consisted of native species but are, to an increasing extent, dominated by alien invaders. As far as known, no native species has became extinct in the Baltic Sea due to introduction of alien species but it cannot be guaranteed that this will be the case in the future. Xenodiversity (structural and functional diversity caused by non-native species) tends to reach and even exceed native biodiversity in terms of number of species and life forms, especially in coastal lagoons and river mouths. This trend towards increasing homogeneity of flora and fauna between, e.g. European and North American continents is one of the most important changes of the geography of life since the retreat of the continental glaciers (Leppäkoski & Olenin 2001).

Effective reduction of the numbers of ship-mediated “stowaways of the seas” is a high priority goal and there are a number of onboard ballast water treatment systems being developed. It is obvious that no single treatment technique alone will be able to eliminate all types of organisms. A combination of different physical (filtering, centrifugation, ultraviolet light and ultrasound treatment) and chemical techniques may prove to be the most effective way. Some basic differences between bioinvasions (biological pollution) and other forms of marine pollution should be kept in mind. While chemical and physical pollution can be reduced or stopped, living organisms tend to reproduce and spread if they meet hospitable environmental conditions in the water body into which they were initially released through shipping or other vectors. Chemicals do not spread actively. Further, chemicals tend to decrease over time through degradation whereas established alien water-living species are permanent, and the impacts of invasive species are usually irreversible.

In the future, climate change may provide species of southern origin with distinct advantage over the native species. In addition, the scenarios are dependent on economic development and political decisions, related to EU transport policy (e.g. trends to develop inland waterways traffic, deepening and widening of canals), and increase of ship traffic for example along the Volgo-Baltic Waterway.

6.7 TABLES

Table 6.7.1. Examples of ecological impacts caused by Ponto-Caspian invasive species in the Baltic Sea, inland European freshwater bodies and North American Great Lakes (from Ojaveer et al. 2002; modified and completed). Species included: *Cordylophora caspia* (brackish-water hydroid polyp), *Cercopagis pengoi* (fishhook waterflea), *Chelicorophium curvispinum* (freshwater shrimp), *Hemimysis anomala* (mysid shrimp), *Dreissena polymorpha* (zebra mussel), and *Neogobius melanostomus* (round goby).

Function/Species	Brackish-water polyp	Fishhook waterflea	Freshwater shrimp	Mysid shrimp	Zebra mussel	Round goby (fish)
Modifies rocky bottom or sediment substrate	X		X		X	
Provides shelter from predators and currents	X				X	
Traps and accumulates organic particles from water	X			X	X	
Increases water clarity (= lowers amount of particles)	X				X	
Affects large aquatic plants	X		X		X	
Redirects energy from water to bottom or *vice versa*	X		X	X	X	
Provides prey to plankton- and/or bottom-eating fish		X	X	X	X	X
Provides food for waterfowl			X	X	X	X
Excludes competing species			X	?	X	X
Increases soluble (bioavailable) nutrients					X	

6.7 FIGURES

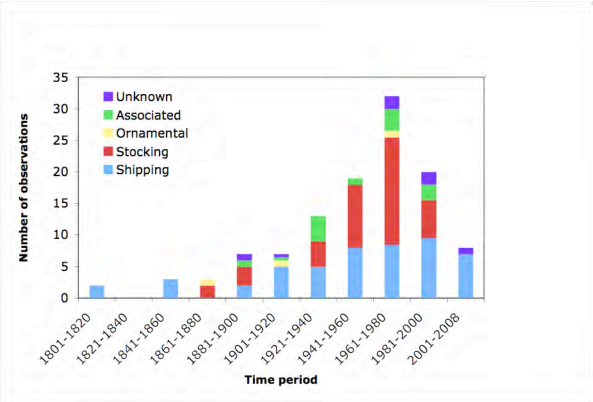


Figure 6.7.1. Number of new alien species observed since the early1800s in the Baltic Sea (Kattegat included) and likely vector of introduction (derived from the Baltic Sea Alien Species Database, October 2008). Note that the last bar only includes the last 8 years while the other bars include 20 year periods**.**

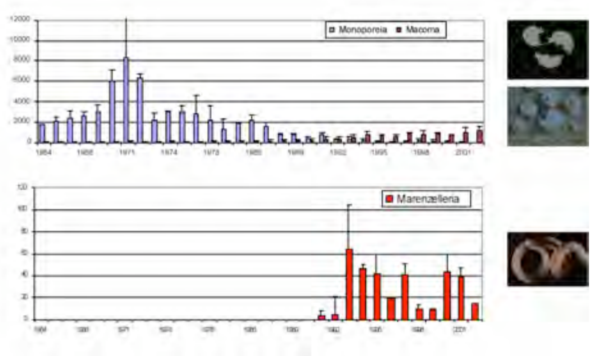


Figure 6.7.2. Long-term changes in Tvärminne area, western Gulf of Finland, in abundance described as density (individuals per square meter on y-axis) of the dominant native species (*Macoma balthica*, the Baltic clam, and *Monoporeia affinis*, an amphipod crustacean) and the invasive North American bristle worm *Marenzelleria* sp. Note the difference in abundance scales (Laine et al. 2001). Photos by Ari O. Laine (*Macom*a and *Monoporeia*) and Johanna Stigzelius (*Marenzelleria*).

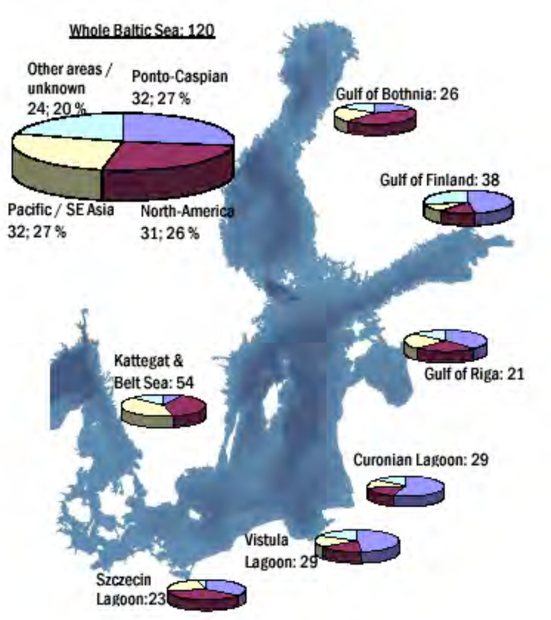


Figure 6.7.3. Number of alien species known to be established in the Baltic Sea according to their area of origin: (1) Ponto-Caspian; (2) North America; (3) South East Asia and Indo-Pacific; (4) other areas or origin unknown. Isohalines indicated (modified from from Leppäkoski & Olenin 2001).

6.7 BOXES

Box 6.7.1. Invasion status of the Baltic Sea as per August, 2008.

Number of species[1)]		
Number of alien species recorded		120
Number of established[2)] species		77
- of them ship-mediated species		40
Major groups[3)]		
Crustaceans (shrimps, crabs, etc)		23
Molluscs (snails, mussels, clams, etc)	9	
Fish		8
Oligochaetes	7	
Polychaetes (bristle worms)	4	

1) The Kattegat included.

2) And some few species the status of which is unknown (in total 25 species).

3) Only species known to be established were taken into account.

Source: Baltic Sea Alien Species Database (http://www.corpi.ku.lt/nemo; update: April 10, 2008)

Box 6.7.2 How do we know which species is a human-mediated newcomer?*)

For most of alien species recorded in the Baltic Sea, there is evidence of their origin achieved through studies of

- paleontological and archaeological record (absence of shells and other remnants),
- historical data (absence in previous surveys and check lists, documented first collection or first release),
- biogeographical patterns (discontinuous distribution, known as introduced from other regions,
- dispersal mechanisms (links to human-mediated vectors, direct evidence of transport),
- molecular genetic evidence, and
- ecological evidence (short larval survival time, community association (e.g. fouling on ship hulls), post-introduction range expansion).

However, is often difficult to determine whether a species is native or introduced; such species with an unknown origin are termed cryptogenic (Carlton 1996).

*) Based on lectures given in 1997 by Prof. James T. Carlton (Williams College, Mystic, Connecticut USA) at Åbo Akademi University

6.8 Noise pollution

Several anthropogenic activities produce noise in the coastal and marine environment, for instance ship traffic, seismic surveys, drilling, SONARs, underwater explosions, extractions and wind farm operations. Organisms that rely on hearing are at risk of being affected by these sounds either by interference with biological signals, exclusion from natural habitats, or even by direct physical harm.

Information on ambient noise levels and actual impact on animals in the Baltic Sea area are largely missing. This section gives an overview of noise generation from activities that are present in the Baltic Sea and known sensitivity of mammals and fish that inhabit the area.

6.8.1 Hearing in the marine environment

The impact of noise depends on the intensity level (loudness) and frequency of the sound, the transmission loss from a source to the animal, and the hearing sensitivity of the animal. An animal can detect the sound when the frequency of the source overlaps with the animal's frequency window for hearing, and if the noise is more intense than the animal's threshold level for hearing. Figure 6.8.1 shows the hearing threshold levels for harbour porpoise (*Phocoena phocoena*), harbour seal (*Phoca vitulina*), and selected fish species as well as the intensity levels of some common anthropogenic activities in the Baltic Sea.

When anthropogenic noise has frequencies similar to biological signals, the noise may interfere with signals used for communication and location, an effect that is called masking. Known behavioral changes of mammals in response to noise include e.g. changing surfacing and breathing patters, disruption of social connections, stress etc. and may result in the active avoidance of areas with high sound levels. In the immediate vicinity of some anthropogenic activities the noise may be loud enough to cause immediate hearing damage to both mammals and fish. For a more complete list of impacts on and responses of cetaceans to anthropogenic noise, see Nowacek et al. (2007).

6.8.2 Activities generating noise in the Baltic Sea

Industrial activities

Industrial noise frequently originates from few, more or less stationary sound sources during resource exploration, extraction, construction and operation of wind turbines as well as use of deterrent devices in fisheries such as pingers.

During pile-driving operations associated with construction e.g. of wind farms, noise is produced at high intensity levels at broad-band frequencies. Pile-driving is estimated to be audible for harbour porpoises and harbour seals at least 80 km from the source (Thomsen et al. 2006) Within this zone the noise can potentially interfere with communication and echolocation clicks. The zone where behavioral changes can be expected range from a few up to 20 km, and hearing loss may occur within a few hundred meters up to a few kilometers from the pile-driving. Hearing capability differs considerably between fish species (Figure 6.8.1). For cod and herring that have relatively good hearing the audible zone is estimated at up to 80 km and behavioral changes are considered possible close to the pile-driving activity (Thomsen et al. 2006).

Operational noise of wind turbines is of lower intensity than pile-driving and the impact on both mammals and fish is likely to be restricted (Madsen 2006). However, noise simulations show that even operating turbines may have a potentially masking effect at least at short ranges in the open sea (Lucke et al. 2007). Direct studies on the response of mammals to operating wind farms are currently taking place in the Danish wind farm "Nysted" (Diederichs et al. 2008, Teilmann et al. 2008).

High-pressure air-guns are commonly used in seismic surveys to produce sound pulses of low frequency and high intensity. There are several observations of behavioral change of mammals associated to air-gun operation, in particular involving avoidance of the area surveyed (Gordon et al. 2003) as well as ceased communication and physical effects on cetaceans (Nowacek et al. 2007). In the immediate vicinity of air-gun operation fish kills have been observed. Reduced catches of fish, e.g. cod, have also been noted in areas of seismic surveys, lasting up to several days after the activity has ceased (Engås et al. 1996).

Industrial seismic surveys use large arrays with multiple air-guns to locate geological structures associated with oil and gas. Air-guns are also used in geological mapping in the Baltic Sea area, usually involving fewer air-guns with lower impact than those used for exploration surveys.

High-frequency SONARs (>10 kHz) that are commonly used to map the seafloor or to locate fish are within the hearing frequency of many marine mammals, but they have a limited transmission range in water. Masking effects cannot be disregarded although concrete evidence is still lacking.

Ship traffic

Shipping constitutes a rather diffuse and omnipresent sound source that is difficult to quantify and evaluate. However, large cargo vessels are considered to be significant contributors to anthropogenic noise in the marine environment. In the period 1950-2000 it is estimated that noise from shipping increased the sound level in the world's oceans by 16 dB, i.e. several times.

The noise emitted from ships varies considerably between vessels, but intense sound levels are mainly of low frequency (<0.5 kHz). The sound produced by shipping is not considered to cause immediate harm to fish and mammals but may cause masking of biologically important information (Southall 2005). Furthermore, the impact of fast ferries such as catamarans has long been recognized as a threat to cetaceans, both for the risk of ship strikes and for their noise emissions. Jet skies are not just fast and noisy but also highly mobile and frequently used very close to the shore thus impacting a habitat that may be less impacted by other noise sources (Koschinski 2008).

Noise from shipping has also been shown to cause increased level of stress hormones in a number of freshwater fish species, among them perch (Wysocki 2006).

Military activities

Mid-frequency SONARs for military purposes have been linked to mass strandings of mammals in several oceanic areas, particularly of deep-diving beaked whales (*Ziphius* spec.), indicating that they may trigger a fatal behavioral response of the species (Nowacek et al. 2007). Fatal behavioural responses to military SONAR appear to be less likely in the rather shallow water body of the Baltic Sea.

Another source of military underwater noise pollution in the Baltic Sea (e.g. in Kiel Bight) are detonations, either when testing new vessels (smaller charges) or when blasting underwater unexploded ordnance (UWUXO), e.g. usually originating from World War II. Underwater explosions are the loudest point source of anthropogenic marine sound. These have the potential to kill or seriously harm marine mammals and fish. Marine mammals exposed to an explosion with a charge weight of 350 kg can be killed by the intense shock wave at a radius of 4 km (Thiele [1998] unpubl. report to the Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik [FWG], Kiel/Germany). The zone of hearing impairment for a harbour porpoise can extend for over 30 km (Koschinski 2007).

6.8.3 Possible mitigation measures

Bubble curtains consist of a fine stream of bubbles constantly rising to the surface thus forming a circular wall around a sound source, e.g., a detonation or pile-driving activities (Würsig et al. 2000). The different densities at the water-air-water interfaces provide a sound reflector and have proven to reduce shock waves by 12 to 18 dB thus reducing the danger area for marine animals by 95 to 98% (Nützel 2008). For the remaining danger zone effective deterrent measures such as pingers, seal scarers and small explosives (charge weight < 20 g) and marine mammal observer schemes are alternatives to lessen the impact. The additional noise emitted into the water column is aimed at driving the animals at risk out of the danger zone, but it will also exclude animals from their preferred habitat. Therefore, this kind of habitat exclusion should only be used for hours at a time with intermittent brakes.

To protect marine mammals, threshold levels have been suggested for a noise exposure criterion combining sound pressure level (200 dB pp re 1 µPa) and sound exposure level (164 dB re 1 $\mu Pa^2/Hz$) to be applied for anthropogenic activities (Lucke et al. 2008).

A number of governments have committed themselves to reducing the impact of noise pollution in the marine environment. For this common goal, several binding resolutions have been adopted in international fora such as conventions and agreements (e.g., ASCOBANS, ACCOBAMS, CMS, IWC and IUCN — see the respective web sites for details). These efforts may lead to generally accepted guidelines for the mitigation of underwater noise pollution (Southall et al. 2007, Weir & Dolman 2007).

6.8.4 Conclusions

As presented in this overview of the impact of noise, there are a number of anthropogenic activities that can cause immediate harm to both mammals and fish in the Baltic Sea. These activities are often localized and short-term, but whenever they proceed during extended periods, they may exclude animals from vital feeding or breeding areas thus causing (temporary) habitat degradation. As far as the impact of noise pollution is concerned, industrial activities such as construction and extraction appear to be of particular concern in the Baltic Sea besides shipping.

Noise of less critical frequencies to marine animals but of a chronic nature, such as that derived from shipping, operating wind farms and high-frequency ship SONAR, may in the long-term pose a more serious risk to marine animals e.g. by masking important biological signals. With an anticipated increase in marine traffic (see this chapter, Maritime activities) and an increasing number of existing and planned technical installations (see this chapter, Physical damage and technical disturbances), noise pollution must be considered to be a growing pressure to the biodiversity of the Baltic Sea.

6.8 FIGURES

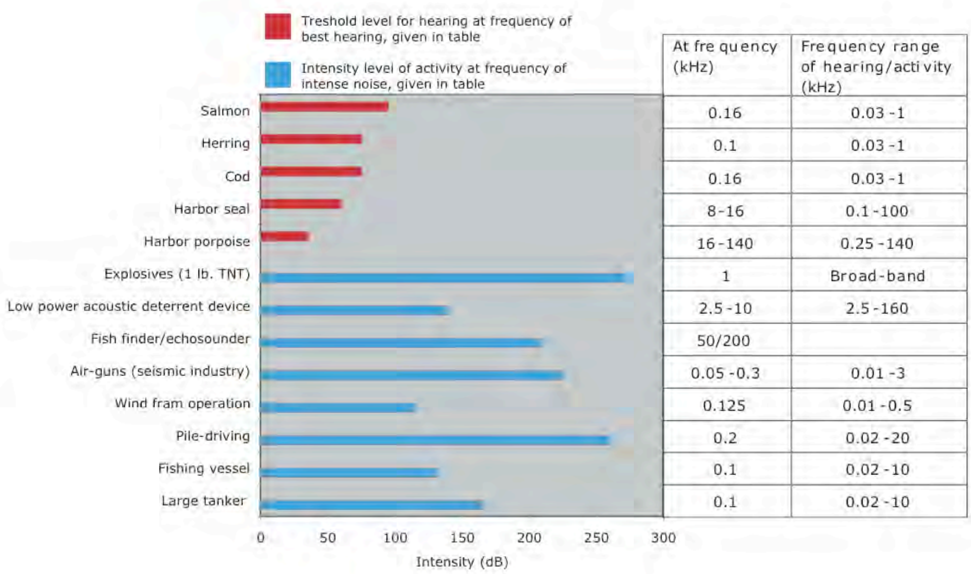


Figure 6.8.1. Hearing sensitivity of marine animals (red) in the Baltic Sea and intensity levels of common activities (blue). Intensity levels for all activities are given at a reference pressure of 1µPa. The information stems from specific systems and models. Variations occur. (Sources:, (NRC 2003, Thomsen et al. 2006) and references therein.

6.9 Hunting

Regardless of the stepping into an industrialized world, hunting has continued to be an important part of human life, also in the Baltic Sea region. Only quite recently, it can be said that hunting no longer provides a significant food source for people. Nevertheless, hunting is still a popular recreational activity and can be considered, in some cases, also as a management measure in nature conservation or in mitigation of harmful interactions between man and nature. In this section hunting is perceived mainly as a pressure to biodiversity in the Baltic Sea.

6.9.1 Hunting of sea birds

Waterfowl hunting has a long tradition in the Baltic Sea riparian states. However, in recent times hunting has decreased as seen in the declining bag size of ducks. One reason for this decrease are hunting restrictions due to the EU Birds Directive. Furthermore, the general interest of hunting seabirds seems to decline (Bregnballe et al. 2006). On the other hand, the bag size of geese shows an increasing trend in several countries (e.g. Poland, Estonia, and German Schleswig-Hostein). One reason may be the increasing populations of Greylag Goose (*Anser anser*) and Canada Goose (*Branta canadensis*) in the Baltic Sea area.

The most important group of game birds are ducks, both dabbling and diving ducks. The species number for which hunting is permitted varies among the countries. In Denmark and Finland, for instance, hunting is practised on 6 dabbling duck and 8 diving duck species, in Sweden on 3 and 8, respectively, whereas the hunting law of the German Federal States Schleswig-Holstein and Mecklenburg-Vorpommern assigns hunting seasons only for 3 dabbling and 2 diving duck species.

Among the diving ducks, the Eider (*Somateria mollissima*) was – and is still – one of the most important target species for hunters, especially in Denmark, Sweden, and Finland (Figure 6.9.1). The total Eider bag of the Baltic Sea area has declined from 150 000-250 000 birds in the 1980s to currently 70 000-80 000. The strong hunting pressure in the 1980s did not prevent the population from growing, though it possibly leads to a decline of growth rates. On the other hand, hunting is certainly not the reason for the currently negative population trend, but it may enhance the decline.

Another important game duck is the Mallard (*Anas plathyrhynchos*). The Danish bag of this species was 554 000-731 000 ducks between 1999/00 and 2003/04. However, the majority of the birds was released from breeding stations just for hunting purposes. In Finland, the Mallard bag weighted 210 000-295 000 birds between 2003/04 and 2006/07. In the German Baltic Federal States Schleswig-Holstein and Mecklenburg-Western Pomerania, the Mallard accounts for more than 90% of the duck bag.

The most important game goose in the south-western Baltic Sea (Denmark and Germany) is the Greylag Goose (*Anser anser*), but White-fronted Goose (*Anser albifrons*), Bean Goose (*Anser fabalis*), Pink-footed Goose (*Anser brachyrhinchus*), Canada Goose (*Branta canadensis*) and Barnacle Goose (*Branta leucopsis*) are also being hunted. Goose hunting is also practised in Finland, Sweden, Estonia and Poland (Table 6.9.1). In Finland, the Bean Goose holds the largest share of the goose bag, followed by Greylag Goose and Canada Goose. In Sweden, the top three species are the same but in an opposite order.

Gulls have been shot in high numbers during the 20^{th} century with the aim to control the population number. The Danish annual gull bag during the 1960s/1970s was in the magnitude of 150 000-230 000 birds (Strandgaard & Asferg 1980). Since then it has declined to 28 000-36 000 (mainly Herring Gull *Larus argentatus*, followed by Great Black-backed Gull *Larus marinus*; Bregnballe et al. 2006). In Finland, the annual permits for gulls (mainly *L. argentatus* and *L. marinus*) are in “tens of thousands” (BirdLife Finland). In Sweden, circa 22 000 gulls were shot in 2005/2006, the bag consisting mainly of the Common Gull *L. canus* and the Herring Gull. The gull bag of the two German Baltic Federal States is currently between 1 000 and 1 500 birds, more than 50% being Herring Gulls. In Estonia, the annual gull bag (2000-2007) varies between 50 and 200 birds.

The Cormorant is not a game bird in the EU member states, since it is not listed in Annex II of the EU Birds Directive. However, the national authorities may allow harassment activities against Cormorants, including shooting, in order to prevent damages on fishery or negative impacts on other species, e.g. Salmon smolts. On this legal basis, Cormorants are shot since the mid-1990s in Denmark, Germany, and Sweden (Table 6.9.1). In Estonia, shooting of Cormorants was started in 1997, but the bag remained low in all years, reaching a maximum of 354 in 2006. In Åland, permission to shoot 100 Cormorants was given in 2008. The total number of Cormorants shot in the Baltic Sea area probably does not exceed 10 000-15 000 birds annually. In Germany, Mecklenburg-Western Pomerania, culling of young Cormorants just before fledging off has been practiced from 2001-2005, but was stopped afterwards because of strong public protests.

6.9.2 Hunting of seals

The grey seal (*Halichoerus grypus*) population has steadily increased after decades of low abundance in the northern parts of the Baltic Sea (see chapter 4, Seals). Along with the seal population increase, conflicts between fishermen and seals have also increased. All three seal species are still legally protected in the countries around the Baltic Sea but annual permits to shoot grey seals are given in Sweden and Finland.

In Sweden, all the seal species were protected during 1989-2000. Since 2001 controlled hunting of grey seals has been allowed from Kalmarsund (North of the Öland Bridge) and northwards according to quotas set by the Swedish Environmental Protection Agency. The geographic delimitation north of the Öland Bridge has been set to avoid mistaken shooting of the small and genetically distinct harbour seal population in the Kalmarsund area. In Finland, quotas have been set from 2000 onwards. The grey seal quotas in Sweden, Finland and Åland were 230, 590 and 450 individuals in 2008, respectively (Figure 6.9.2). In Sweden and Finland, individual permits can be applied for shooting harbour seals (*Phoca vitulina*) and ringed seals (*Phoca hispida botnica*). Between 12-26 harbour seal permits have been granted annually in Sweden in 2003-2007 and the first ringed-seal permits were granted in 2008 in Finland. Sweden has a management plan for grey seal and action plans for ringed seal and harbour seal in the Baltic proper and a management plan for harbour seal in the Kattegat is under development[15]. There are management plans for both grey seal and ringed seal in Finland[16]. Seal hunting is not allowed and permits not given in any other country in the Baltic Sea.

6.9.3 Major international frameworks regulating hunting of seabirds and seals

The main legal frameworks regulating hunting in the Baltic Sea region are the EU Habitats and Birds Directives. All the seal species in the Baltic Sea are protected by the Habitats Directive and the Birds Directive protects all the seabird species in the area. However, Member States can set specific quotas for game species and their hunting is regulated temporally and spatially. Permits to shoot other than game species must be individually applied for from national authorities. However, the hunting of birds has been limited only to autumn and the Member States are obliged to adjust the quotas and individual permits of the species in order to not threaten the breeding populations of the species. The Bern Convention for protection of wildlife and natural habitats lists all the three seals in its Annex III as protected species, hunting of which is strictly regulated.

6.9.4 Conclusions

According to current knowledge and assessments, waterfowl hunting in the Baltic Sea area in general seems to be sustainable. Most species for which hunting is permitted have a favourable conservation status and stable or increasing populations (Bregnballe et al. 2006). However, there are also some species with decreasing population trends and unfavourable population status (e.g. Eider, Greater Scaup *Aythya marila*, Long-tailed Duck *Clangula hyemalis*). For these species, a Baltic-wide hunting ban should be strived for, since hunting, though certainly being not the main reason for the current negative trends, may put an additional pressure on the populations and contribute to their decline.

Hunting of seals and sea birds cannot be seen as a management measure from a biodiversity point of view. However, shooting of American mink and Raccoon dog, which are non-indigenous mammals in the Baltic Sea

15 Available at: http://www.naturvardsverket.se/upload/04_arbete_med_naturvard/jakt/forvplan.pdf

16 Available at: http://www.mmm.fi/sv/index/framsida/fiske_vilt_renar/Viltvard/forvaltningsplaner/forvaltningsplanenforostersjonssalstammar.html

coastal and archipelago areas, have resulted in increased biodiversity in the region. For example, in Finland their killings range between 85 000 and 135 000 annually, which has led to manifold breeding success of many seabird species and increased species richness in archipelago areas. Thus, hunting cannot be seen only as a pressure but also as a way to mitigate another anthropogenic impact, namely alien species.

6.9 TABLES

Table 6.9.1. Waterfowl bag of the Baltic Sea riparian states.

Country	Bird group	Annual hunting bag	Remarks	Source
Denmark	Ducks Geese Gulls Cormorants	200 000-250 000 18 000-29 000 28 000-36 000 2 400-4 900	1999/00-2003/04	Bregnballe et al. (2006)
Estonia	Ducks Geese Gulls Cormorants	7 000-17 700 900-4 800 0-200 0-354	1992/93-2007/08	Statistics Estonia http://pub.stat.ee
Finland	Ducks Geese	443 000-608 000 15 000-24 000	2003/04-2007/08	Hunters' Central Organisation & Finnish Game and Fisheries Research Institute
Germany – Schleswig-Holstein	Ducks Geese Gulls Cormorants	60 000-70 000 4 500-8 500 800-1 100 100-1 100	1996/97-2006/07 2005/06-2006/07 no gull hunting 2002-2005 1992/93-2006/07	MLUR SH 2007
Germany – Mecklenburg-Western Pomerania	Ducks Geese Gulls Cormorants	7 100-15 500 2 300-11 700 100-300 200-1 600	1992/93-2007/08 2005/06-2007/08 1992/93-2007/08	LU MV 2006
Latvia	Waterfowl	2 500-3 000	2005-2006	
Lithuania		no information		
Poland	Ducks Geese Gulls	100 000-160 000 4 000-17 000 no game bird	1990/91-2007/08	Research Station of the Polish Hunting Association
Russia, Kaliningrad region		no information		
Russia, St Petersburg region		no information		
Sweden	Ducks Geese Gulls Cormorants	101 000 32 000 22 000 2 000	2005/2006	Swedish Hunting Association

6.9 FIGURES

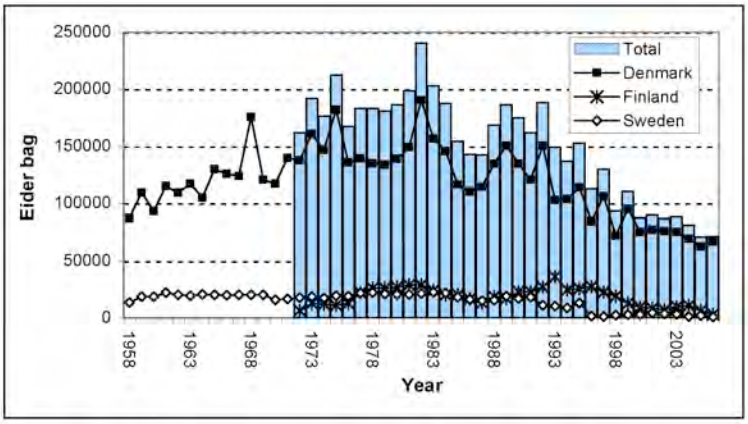


Figure 6.9.1. The development of the Eider bag in Denmark, Finland and Sweden. The Finnish data does not include Åland. Data provided by the Danish National Environmental Research Institute, Finnish Game and Fisheries Research Institute and the Swedish Association for Hunting and Wildlife Management.

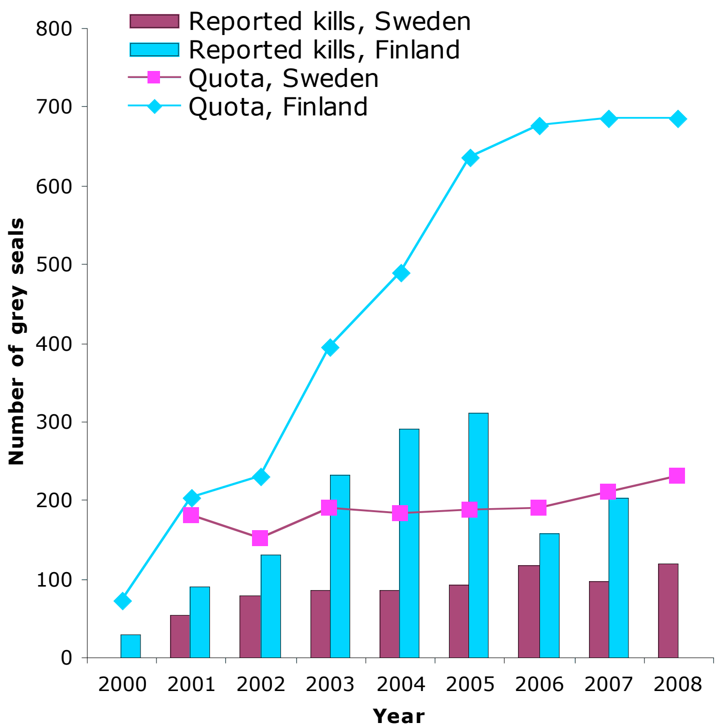


Figure 6.9.2. Quotas and killed grey seals in Finland (excl. Åland) and Sweden during 2000-2008.

6.10 Future climate change

The Intergovernmental Panel Climate Change (IPCC) indicates that warming of the climate system has been unequivocal with a 0.74ºC linear trend over 1906-2005 (IPCC 2007). The IPCC also indicates that most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The panel is also clear in its view that if continued at current or higher rates, emissions of greenhouse gases will cause further warming and induce many changes in the global climate system during the 21st century.

According to the BACC project (BALTEX[17] Assesssment of Climate Change in the Baltic Sea Basin) air temperature in the Baltic Sea region has warmed by about 0.08°C per decade during the period 1871-2004 and the trend is thereby slightly greater than in the global time series (Heino et al. 2008). The Baltic time series shows similar trend for all seasons and indicates that the southern parts have warmed more than the northern ones.

Climate has a profound effect on hydrology, hydrography and subsequently the marine environment of the Baltic basin. The climate is influenced by major air pressure systems, particularly the North Atlantic Oscillation (NAO) during wintertime, which affects the atmospheric circulation and precipitation in the Baltic Sea basin. The North Atlantic pressure fields affect Baltic hydrography since the water exchange between the Baltic Sea and the North Sea is largely driven by strong and persistant eastern and western winds (Lass & Matthäus 1996).

During recent decades there has been a decreased frequency of salt water pulses from the North Sea into the Baltic (Heino et al. 2008). Observational data also shows that annual surface temperature has increased by ca 1°C in the southern Baltic Sea (Beaugrand et al. 2008), whereas in the northern Baltic Sea the observed changes are mainly seasonal (Rönkkönen et al. 2004). The ice season has also decreased by 14-44 days during the last century. These changes have had a measurable effect on the distribution, reproductive output and stock sizes of the Baltic biota (see e.g. chapter 3, fish communities and zooplankton communities). However, it has not been possible to establish a link between these changes and anthropogenic climate change due to the natural variability in climate as well as impacts from other human pressures (Dippner et al. 2008). The observed changes however point to the considerable impacts that climate related factors have on the Baltic Sea biodiversity.

Regional climate models for the Baltic Sea area predict an increased precipitation during the 21st century which will cause a more permanent decrease in salinity. Hydrographic models also predict a higher seawater temperature in the Baltic Sea. This section addresses possible impacts of these predicted changes in climate on the Baltic Sea biodiversity.

6.10.1 Predicted changes in climate and hydrography in the Baltic Sea region

The latest modeling on future warming predicts that air temperatures will still increase by 3-5°C during this century (Graham et al. 2008, Heino et al. 2008). This means 20-50 and 30-90 days longer growth seasons in northern and southern areas of the region, respectively. Conversely, this means shorter winters, which will be seen as one to three months shorter ice season, the shortening being smaller in the northern areas.

During the 21st century, anthropogenic climate change is expected to increase precipitation, particularly in the north, while summers will become drier in the south (Graham et al. 2008, Heino et al. 2008). This is predicted to cause 15% higher riverine runoff during winters (averaged for the whole area), causing decreased salinity in the Baltic Sea and higher nutrient loads from the surrounding catchment area. Oceanographic studies show that average annual sea surface temperatures could increase by some 2 to 4°C by the end of the 21st century (Döscher & Meier 2004, Räisänen et al. 2004).

17 Web site of the BALTEX project: http://www.baltex-research.eu/

Because the sea is a major CO_2 sink, storing about 30% of the anthropogenic CO_2 emissions, long-term increase of CO_2 is seen as acidification of the seawater (Sabine et al. 2004). According to IPCC models, pH in the world oceans will drop by 0.30 by 2100 given the increase of CO_2 concentration to 650 ppm (Caldeira & Wickett 2005). In the Baltic Sea, acidification by 0.15 pH units has already been found during the last 20-30 years (Perttilä 2008). Acidification of sea water leads first to decrease of calcification and, in lower pH, to dissolution of calcified structures of e.g. certain plankton groups, bivalves and snails. In the Baltic Sea, where calcification is already lower due to low salinity this effect may be greater than in the oceans.

Predicted ecosystem effects of increased seawater temperature

Globally, rising water temperatures have already caused range shifts and changes in abundance of algae, plankton and fish in some freshwater and marine systems (IPCC 2007). An increase in water temperature may also increase bacterial activity, which can affect nutrient recycling and biological uptake (HELCOM 2007). Higher summer temperatures and milder winters will likely bring new species, alter migration patterns of birds and result in exclusion of some native species or ecosystem functions of the Baltic Sea. Warming may, for example, stimulate warm-water phytoplankton such as cyanobacteria, whereas cold-water species, such as diatoms, may decrease in the system (Dippner et al. 2008). On the other hand, it has also been suggested that the occurrence of cyanobacterial blooms may decrease due to altered bottom oxygen concentration or inhibited vertical mixing of the water column. The contradictory predictions highlight that impacts of future climate changes are highly uncertain. Altered ice conditions are expected to change the timing of phytoplankton blooms and alter the Baltic pelagic food web.

Because ringed seals and grey seals give birth to pups on ice, a lack of ice cover resulting from anthropogenic climate change is expected to reduce the reproductive success of these species (ICES WGMME Report 2005). Some seals have been observed to give birth to pups on land, but it needs to be noted that this exposes the pups to predation and that the majority of pups born on land die before weaning. In particular, ringed seal pups survive only rarely in such cases, since their mothers need to feed themselves during the suckling period.

Lack of ice, particularly the lack of its scraping impact on shallow water areas, may also cause changes in littoral communities. Ice-scraping has an important role in successive plant dynamics in the Baltic Sea, both for vascular plants and algae (e.g. Kiirikki 1996). Moreover, the ice cover supports a specialized microscale food web in itself, since microbial organisms occupy interstitial crevices and salt water channels within the ice (Kaartokallio et al. 2005, Granskog et al. 2006). Such a unique microbial system will be lost together with the disappearing sea ice.

Predicted effects of increased runoff and decreased salinity

The predicted increase in riverine runoff will result in higher loading of nutrients and sediment. This will be more significant in the northern parts of the region. An increase in nutrient loading will have an influence on phytoplankton species composition and primary production, and will contribute to increased eutrophication. Increased sediment load from the run-off will also deteriorate rocky habitats as the hard substrata will disappear. This will happen particularly within and near estuaries. Increased organic matter in the water column will on the other hand shade phytoplankton and may stimulate growth of bacteria, resulting in a food web more based on heterotrophy with reduced productivity at higher trophic levels as a consequence (Berglund 2007). Impacts on the ecosystem level are clearly difficult to predict at present.

According to model predictions, surface water salinity will decrease in the Baltic Sea due to increased precipitation and outflow of less saline water through the Danish Straits. This will lead to stronger stratification of the water column and displacement of the halocline to greater depths, resulting in less mixing of deep water and higher probability of oxygen depletion in deep basins. Deepening of the halocline will result in a larger area of oxygenated sediments increasing the area available for colonisation of macrofauna above the halocline (Dippner et al. 2008).

Species which are clearly limited by salinity can be used as indicator species and may become an important tool for assessing the impacts of climate change. Although it may be too early to predict the changes at the species-level, the first candidates to suffer could be species present in the northern parts of the Baltic Sea. Many Baltic marine species meet their salinity limit in the northern Baltic Sea and this is where fresh-water inflow is predicted to increase the most. Many ecologically significant species will probably disappear from the northern Baltic Sea, such as bladder wrack (*Fucus vesiculosus*), eelgrass (*Zostera marina*), blue mussel (*Mytilus trossulus*), flounder (*Platichthys flesus*), turbot (*Psetta maxima*), and many red algal species (Laine 2008).

In the southern parts of the basin there are several algal species, which require higher salinities. In the predicted low salinity conditions, many algae will be expected to disappear from their former ranges, e.g. the brown alga *Fucus serratus*, the kelp *Laminaria saccharina*, various crustose red algae (e.g. *Lithothamnion glaciale*), the red alga *Delesseria sanguinea*, and the green alga *Ulva lactuca*.

Many littoral invertebrate species in the northern Baltic Sea, living among macroalgae and vascular plants or in soft bottoms, have lowest salinity limits close to 4-6psu (e.g. the shrimp *Crangon crangon*, the isopod *Idothea baltica* and the soft-shelled clam *Mya arenaria*). Similarly, in the south-western Baltic Sea, many oceanic species may withdraw from the Baltic side of the Danish straits. Such invertebrates may be, for example, the crabs *Carcinus maenas* and *Hyas araneus*, and the *Littorina* snails.

Spawning of the most important commercial fish species in the Baltic Sea, cod, is dependent on salinity of more than 11 psu. Thus, reduced salinity together with potentially increased hypoxia in the Baltic Sea will diminish the volume of cod's spawning habitat (Nielsen & Kvaavik 2007). Since many of the above-mentioned species are key stone species in the Baltic ecosystem, the cascading impacts will most likely resonate in other species in both the marine ecosystem as well as terrestrial coastal communities.

Secondary effects of decreased salinity are also predicted. The changes in environmental conditions may give opportunities for non-native species to invade the ecosystem. Moreover, marine species living at their tolerance limit of low salinity are more sensitive to other metabolic stresses such as higher temperature and hazardous substances. Higher temperatures and/or lower salinity could therefore affect the species' ability to deal with toxic substances and the different physiological regulation processes involved in the detoxification of hazardous substances. Because bioavailability of metals correlates negatively with salinity (Dippner et al. 2008), the tolerance of species will likely be exceeded.

6.10.2 Conclusions

Hydrographic changes in the Baltic Sea have already altered distributions and ecological interactions of the Baltic biota and modelled predictions of anthropogenic climate change indicate that even more pronounced changes can be expected during this century. As the strongest abiotic parameter regulating the Baltic biota is salinity, the predicted decrease in salinity will inevitably change the geographic distribution limit of many species and even exclude native species from the Baltic Sea. Most likely, the emerging freshwater species will replace some of the functions of marine species, but the capability of freshwater species to compensate for the loss of habitat-forming marine species is difficult to predict. By monitoring certain indicator species, known to be sensitive to changing hydrographic regime, the future ecosystem effects could be better predicted.

The changing climate will put considerable stress on the Baltic ecosystem, making it even more important to mitigate other human pressures. Known associations between salinity, temperature, toxic substances and establishment of invasive species, for example, indicate that polluted environments, which undergo also hydrographic changes, experience highest establishment rates of non-indigenous species.

CHAPTER 7: STATUS OF THE NETWORK OF MARINE AND COASTAL BALTIC SEA PROTECTED AREAS

The aim of a Baltic Sea network of coastal and marine protected areas is to contribute to the protection of the entire ecosystem with all its components and functions and not just specific species or habitats. Baltic Sea Protected Areas (BSPAs) should therefore be adequately distributed across the Baltic Sea and its different sub-regions to include all species, habitats and ecosystems, ensuring genetic diversity in the network.

According to the HELCOM Baltic Sea Action Plan (BSAP) the improvement of the protection efficiency of the network of marine BSPAs is a central action in order to reach all HELCOM ecological objectives (HELCOM BSAP 2007).

Although BSPAs are in most cases not designed as no-take or no-use zones, they can serve many different purposes (Kelleher 1999, Salm et al. 2000) such as:

- Help to halt degradation of the marine ecosystem and facilitate its regeneration.
- Contribute to protection of biodiversity and increased productivity.
- Help to protect genetic diversity.
- Contribute to the protection of natural habitats and species.
- Maintain natural reference areas (for research and education).
- Provide refuges and living spaces for different life stages of exploited species (e.g. from fisheries).
- The aim of this chapter is to assess the current status of the BSPA network in the Helsinki Convention area (Figure 7.1).

7.1 History of Marine and Coastal Baltic Sea Protected Areas

Initial suite of 62 BSPA sites

HELCOM started as early as 1994 to establish a system of marine and coastal Baltic Sea Protected Areas (HELCOM Recommendation 15/5). All Contracting States to the Helsinki Convention contributed by identifying and nominating an initial suite of 62 sites towards establishing a coherent network of BSPAs. Contracting States committed themselves to define definite boundaries and management measures for these sites as soon as possible, and to include additional BSPAs, particularly offshore sites outside their Territorial Waters.

In order to implement Recommendation 15/5, the HELCOM Working Group on Nature Conservation and Biodiversity in 1996 agreed on Selection Guidelines for BSPAs. Further it compiled a comprehensive overview of all existing coastal and marine protected areas (not only BSPAs) in the Baltic Sea area (HELCOM 1996). This work was followed by an intensive assessment showing that there already existed a wide range of coastal terrestrial and nearshore marine protected areas in all Baltic Sea states. However, many of these were not included in the BSPA system, although they would have qualified according to the expert opinion. Additionally, the assessment showed that there was a Baltic Sea-wide lack of offshore protected sites. Consequently, an expert opinion was commissioned to identify potential offshore BSPAs. Hägerhäll & Skov (1998) proposed 24 ecologically significant offshore sites, but only some of them were subsequently designated as new BSPAs.

In 2003, the HELCOM and OSPAR Commissions met for the first time in Bremen, Germany. In the high level meeting, ministers reaffirmed their commitments to establish a coherent network of well-managed marine protected areas by 2010 (hereafter referred to as the 2010 target) and adopted a Joint Work Programme (JWP) for the OSPAR and HELCOM convention areas.

Nomination of Natura 2000 sites as BSPAs

Natura 2000 is a network of protected areas legislated by the European Union (Box 7.1). Today, within HELCOM, 8 of the 9 riparian states are EU Members and thereby bound by these directives, whereas Russia is the only exception. The Emerald Network under the Bern Convention is complementary to EU's Natura 2000 network in non-EU countries in the entire European continent and some states of Africa. Although Russia has not signed it, it could nominate sites to the network. For Russia the relevant international agreements related to MPAs are the Ramsar convention, the Convention on Biological Diversity and the Helsinki Convention.

HELCOM sought to combine efforts with the European Union to implement the HELCOM/OSPAR Joint Work Programme on MPAs. In this context HELCOM (HOD 18) in 2005 decided that "…the designation of NATURA 2000 sites by the EU Member States and other sites by the Russian Federation as BSPAs is accepted by HELCOM as the adequate implementation measure with regard to HELCOM Recommendation 15/5 and a contribution to the Joint Work Programme on MPAs. In such cases, Contracting Parties are under no obligations to take any further action in respect of these areas than those which arise from the Birds and Habitats Directives of the European Union ..."

In contrast to the network of marine protected areas of HELCOM, which is a recommendation, the establishment and management of the Natura 2000 network is legally enforceable. Currently the European Commission has already warned various EU member states regarding non-compliance with the Birds and Habitats Directives. This includes also HELCOM Contracting States with respect to the Baltic Sea area.

Guidelines for the Management of BSPAs

Based on the work conducted jointly by HELCOM and Germany, HELCOM and OSPAR have commonly developed practical guidance for establishing management plans for BSPAs and OSPAR MPAs (HELCOM 2006). This guidance is based on an IUCN model (Salm et al. 2000) and contains detailed instructions and stipulations on the management of BSPAs. It also includes guidance on international regulation options for conflicting maritime activities for which coastal states have only limited legal competence, in particular for shipping and fisheries (for EU Member States).

However, where Natura 2000 sites are reported as BSPAs, Contracting States may manage them according to the legally binding requirements of the EU Habitats and/or Birds Directives. This means that with regard to Natura 2000 sites it may be sufficient to define and implement management measures without producing comprehensive management plans.

Reassurance by the Baltic Sea Action Plan

In the Baltic Sea Action Plan, signed in November 2007 in Krakow, Poland, the governments of the Contracting States recalled the former commitments to establish a coherent network of BSPAs.

They decided, to “designate by 2009 already established marine Natura 2000 sites, where appropriate, as HELCOM BSPAs and to designate by 2010 additional BSPAs especially in the offshore areas beyond territorial waters”.

Further they agreed to improve the protection efficiency of the BSPA network by 2010, by assessing the ecological coherence of the BSPA network together with the marine Natura 2000 sites, and where possible, to finalise and implement management plans or management measures.

The importance of marine protected areas according to the Marine Strategy Framework Directive

As the BSAP will serve as a regional approach to implement the Marine Strategy Framework Directive (MSFD) in the Baltic Sea, it is also of utmost importance for the protection of the Baltic Sea under the coming European Maritime Policy. EU Member States are to report by 2012 the ecological status of their marine waters, which includes assessments of conservation status of marine species, habitats and landscapes as well as of human impacts on the marine environment. In this context, the information on the marine environment, collected in the BSPA database and other HELCOM databases, should also be considered in the (regional) implementation process of the MSFD, e. g. when identifying indicators under the MSFD.

The MSFD additionally requires Member States to make information on MPAs publicly available by 2013 and by 2015 to identify and by 2016 to undertake chosen actions to reach and/or maintain the good ecological status of the marine environment.

7.2 Assessment of the ecological coherence of the BSPA network

The Joint Work Programme (JWP) obliges Contracting States to "consider how Baltic Sea Protected Areas … in the waters under the jurisdiction of EU Member States, together with the Natura 2000 network, can constitute a coherent network of marine protected areas". Therefore, HELCOM agreed on objectives and criteria for the assessment of the status and the ecological coherence of the network as listed in Box 7.2 and which are based on works by Day & Roff (2000) and Laffoley et al. (2006). The HELCOM definition of ecological coherence includes four criteria: adequacy, representativeness, replication, and connectivity. In practice, these criteria take into account, MPA size and shape, coverage of species, habitats and landscapes, location of the MPAs across biogeographic scales, replication and connectivity at different scales. The EU Interreg III B project BALANCE project (Piekäinen & Korpinen, 2008) and OSPAR (2007) have provided further advice on how the criteria on ecological coherence can be made operational.

In 2004, HELCOM developed a comprehensive database on Baltic Sea Protected Areas (http://bspa.helcom.fi) that is used together with the HELCOM GIS for assessments and spatial analyses. Currently (as October 2008), the BSPA Database contains information on 113 different sites, of which 89 are officially nominated as BSPAs. The BSPA database contains information on size and boundaries, legal protection, management as well as occurrence of species, habitats and biotopes within the sites, which are used to assess the ecological coherence of the BSPA network. In order to meet the requirements from the JWP, HELCOM produced a first assessment of the BSPA network in 2006 with the conclusion that the network was neither coherent nor complete (HELCOM 2007a). The assessment has been updated for this report. The HELCOM assessment relied on the HELCOM Red lists of threatened and/or declining habitats/biotopes and species (HELCOM 2007 b) and the information in the BSPA database. A spatial GIS analysis was used in assessing coherence of the network.

In addition to the HELCOM assessment of the BSPA network, the BALANCE project did a complimentary assessment of the ecological coherence of the BSPA and Natura 2000 networks in the Baltic Sea (Piekäinen & Korpinen, 2008). This assessment was mainly based on benthic marine landscape maps (**see chapter on marine landscapes**), which in the absence of continuous maps of benthic habitats at the Baltic Sea scale were used as proxies for the broad-scale distribution and extent of ecologically relevant entities of the seafloor (Al-Hamdani & Reker 2007). The analysis was carried out using spatial analyses to look at e.g. the distribution of sites as well as the coverage of marine landscapes within the protected sites compared to the total amount, distribution and coverage in the entire Baltic Sea. Unlike the HELCOM assessment, BALANCE assessed all sites in the HELCOM BSPA database that were classified as "notified and designated" as well as those that were "proposed by recommendation 15/5, but still not designated" - at that time in total 92 sites.

The combined conclusions of the two analyses carried out by HELCOM and BALANCE [18] are described below.

Adequacy of BSPAs

An adequate MPA has appropriate size, shape, location and quality to ensure the ecological viability and integrity of the populations, species and communities for which it is selected. As a set, the individual MPAs should together fulfil the aims of the entire MPA network. For instance, protection efficiency, the level of influence from the adjacent environment (e.g. anthropogenic disturbance) and location of MPAs (pelagic vs. coastal) are important considerations when assessing adequacy of a site. At present, the BSPA network can be described as the following:

Size: The HELCOM Recommendation 15/5 and its specific Guidelines state that a minimum size for a terrestrial site should be 1 000 ha and for a marine/lagoon BSPA 3 000 ha[19]. The size of almost all (94%) of the 89 designated and managed marine BSPAs (excl. terrestrial parts) exceeds 1000 ha and 78% of the sites are larger than 3 000 ha. The size distribution of BSPAs in each of the HELCOM Contracting States is shown in figure 7.2.

18 The BALANCE information on ecological coherence, which is quoted in the following sections, is taken from Piekäinen & Korpinen (2008).

19 HELCOM Recommendation 15/5 and its specific Guidelines . Available at: http://www.helcom.fi/Recommendations/guidelines/en_GB/guide15_5

Total coverage and distribution: The World Summit on Sustainable Development, and subsequently the Convention on Biological Diversity, adopted a global target for 10% of all marine ecological regions to be effectively conserved by 2012[20]. According to the HELCOM database currently ca. 6% of the Baltic Sea marine area is covered by the 89 designated and managed BSPAs, with a total area of 22 569 km^2 (Table 7.2). However, it should be pointed out that HELCOM itself has not yet agreed on any percentage of the Baltic Sea area to be covered by BSPAs as target. If adding also terrestrial sites, the network covers in total 27 405 km^2.

The network of BSPAs covers examples of all the sub-basins of the Baltic Sea (Figure 7.1). According to the BSPA database, the coverage varies from 2 to 36% in the 18 HELCOM sub-regions; with the lowest coverage, less than 5%, in the largest sub-regions e.g. the Eastern and Western Gotland Basin and the Bothnian Bay (Table 7.3). Although the current network of BSPAs covers coastal terrestrial, near-shore marine, and offshore marine areas, a considerably larger share is found within the Territorial Waters (i.e. coastal waters extending up to 12 nautical miles from the base line) where, according to the current situation, about 7.6% of the total sea area is covered by BSPAs, compared to the Exclusive Economic Zone (EEZ) where only about 2% of the area is covered (Table 7.2).

The network of designated BSPAs has significantly enlarged since the Joint Work Programme was agreed in 2003 (Table 7.1 and 7.2), especially in the EEZ. Sweden and Denmark have designated one offshore site each within their EEZ, and Germany three sites. Additionally, Sweden and Denmark have two sites and Latvia has one site designated partly within their EEZs.

Legal protection and management: Relevant and efficient management is crucial to secure long-term protection of the sites. According to HELCOM (1996) and the BSPA database (in October 2008), 67 of the 89 designated BSPAs are at least partly (parts of the total area) protected under national legislation, i.e. they are classified, e.g. as national parks or nature reserves (Figure 7.3). All sites in Poland and the majority of the sites in Finland, Latvia and Lithuania are protected by national legislation while in the other countries only about half of the BSPAs are protected partly or fully under their legislation. Nearly all (98.6%) BSPAs are also designated as EU Natura 2000 sites, thus ensuring the protection of at least the Natura 2000 habitats and species listed in the annexes to the Birds and Habitats Directives. If looked specifically within the EEZ, half of the ten sites – either fully or partly in EEZ – have national protection, whereas 20% are partly and 30% not at all protected by national legislation. Because 90% of the EEZ sites are in the Natura 2000 network, the level of international protection in the EEZ is high.

Currently, management plans have been implemented in 28 BSPAs. In addition, in 6 BSPAs draft plans exist, but have not been implemented, and in 35 sites the management plans are under preparation. For 20 designated BSPAs the management plan either does not exist or the database does not contain any information about it.

Representativeness

To contribute to the protection of the entire ecosystem the full range of species, habitats, landscapes and ecological processes present within a sea area should be adequately represented within the BSPA network.

Species: In the HELCOM BSPA database, a total of 207 species are reported to exist within the 89 designated BSPAs. The majority are birds, including nesting, migratory and wintering species (Figure 7.4). Only 10% of the reported species are plants, 5% mammals and only 1% algae. Most of the 21 vascular plants reported to be included within the current network are terrestrial and less than 25% are partially submerged species. However, 31 BSPAs in the database do not include any information on species at all. It is obvious that the database contains deficient information on wide-spread and common species.

The HELCOM lists of threatened and/or declining species and biotopes/habitats of the Baltic Sea Area (HELCOM 2007 b) contain 61 species, which are in urgent need of protective measures and for which protection is also highlighted in the BSAP. Bird and mammal species listed in the HELCOM List are well

20 Convention on Biological Diversity, COP7 Decision VII/30/Annex2, target 1.1. UNEP/CBD/COP/7/21 (20 February 2004), e.g. at page 385.

represented by BSPAs, whereas the other taxa are less represented. According to the BSPA database, 29 of the 61 threatened and/or declining species are not included in the current BSPA network at all.

Habitats, biotopes, landscapes: The HELCOM lists of threatened and/or declining species and biotopes/habitats of the Baltic Sea Area (HELCOM 2007 b) also include 16 biotopes and habitats which are in urgent need of protective measures and which protection is also postulated in the BSAP. At present, 7 of these biotopes and habitats are reported to be represented within the BSPA network. However, the database lacks information on several biotopes and habitats e.g.: seagrass beds; macrophyte meadows and beds; gravel bottoms with Ophelia species; Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation; maerl beds; and sea pens and burrowing megafauna communities. Due to data deficiency, it is difficult to assess whether these are adequately covered by the BSPA network.

To assess if the species and habitats are adequately represented in the BSPA network it is also necessary to look at the proportion of the total distribution of different species and habitats in the entire Baltic Sea that is covered by the protected sites. Many marine studies and international conventions have suggested that ecologically functional networks of marine protected areas need to cover *at least* 20% of each habitat in a region to secure long-term viable populations and protection of the ecosystem (reviewed in Piekäinen & Korpinen 2008), but that regionally rare, sensitive and threatened habitats and species may need a larger proportion protected.

In the BALANCE project, a spatial analysis was carried out to look at the proportion of the total area of the benthic marine landscapes that is covered by the BSPA network. The analysis showed that as many as two thirds (41) of the 60 benthic marine landscape types are insufficiently represented within the BSPA network compared to the recommended minimum 20% level (Figure 7.5). The 19 landscape types having the highest representation comprise mostly landscape types in the shallow euphotic zone. Moreover, areas where the bottom substrate is dominated by bedrock, hardbottom complex or sand have the highest proportionate coverage, whereas there is much lower representation of mud and hard clay. To summarise it can be concluded that the major gaps in marine landscape representativity are in the deep water areas where landscapes are dominated by hard clay and mud.

Replication

Adequate replication of features in MPA networks, within and across biogeographic regions, is needed to ensure that the natural variation of the feature is covered - at a genetic level, within species or within habitat and landscape types and also to spread the risk against damaging events and long-term changes. This enhances the resilience of the ecosystem, increases representativeness and also adds to the number of connections between sites.

Replication can be assessed by looking at the number of spatially separated patches of each protected feature within the network, e.g. individual seagrass meadows or rocky reefs. Because the overall distribution of habitats and species is still poorly known in the Baltic Sea, this cannot be fully assessed at the present.

Based on the information in the BSPA database 62, out of the totally 207 species reported within the BSPA network, are found in 10 or more BSPAs. Of these 62 species, 60 are birds and two are mammals. However, half of the 207 species are reported from less than 3 sites within the BSPA network. Thus, according to the database, many species lack spatial replication. To fully assess the replication in the BSPA network, reliable information of algae, amphibians, vascular plants and invertebrates is needed.

In the BALANCE project, a spatial GIS analysis was carried out to look at the number of spatially separate replicates of different marine landscapes covered by the BSPA network. The result of the analysis showed that replication of the benthic marine landscape patches is very variable, ranging from zero to hundreds of replicates for different landscape types. The majority of the poorly replicated landscape types were bedrock and hard clay landscapes. The shallow euphotic bedrock landscapes had none or only one replicate, the same applied for non-photic bedrock, and most euphotic and non-photic hard clay landscapes. As BSPAs are generally rather large, the within-site replication of landscape patches is relatively high while the number of sites hosting the replicates and thereby the between-site replication is often low. However, the ecologically meaningful minimum number of replicates and the minimum size for a replicate are strongly dependent on species characteristics.

Connectivity

To ensure good connectivity, the BSPA network should offer sufficient opportunities for dispersal and migration of species within and between MPAs. Connectivity depends mainly on the *dispersal distance* of the individual species (incl. e.g. larvae and juveniles) and the *distance between preferred habitats* for those species. Evaluating connectivity is somewhat problematic as the network aims to protect a wide range of species which have highly different ranges of dispersal and mobility, both between species and at different stages in their life. Many bivalves (e.g. mussels and cockles) have dispersal distances as long as 100 km, while for swimming crustaceans and some seaweeds the distance is at most 25 km. The network should therefore take into account different aspects of connectivity and not be focused on one element or one species to the detriment of others. The network design should also take into account different life history stages of species. It has, however, been repeatedly suggested that, if the network is not targeted to a certain species, an average distance of 25 km can be used between MPAs (Botsford et al. 2001, Shanks et al. 2003, Palumbi 2004, Halpern et al. 2006).

Because the HELCOM database contains no spatial information on habitat and species distribution and such data is currently not available, an approach of hypothetical straight-line connectivity with 20 and 50 km buffers (i.e. 40 km and 100 km connectivity distance) was used in the HELCOM assessment (Figure 7.6). The assessment showed areas of good connectivity but also indicates major gaps, particularly in offshore areas.

In the BALANCE project, connectivity was assessed between protected patches of similar benthic marine landscapes – both by using a fixed 25 km distance and by using a species by species approach where the considered landscapes and distances were set depending on the specific requirements for the selected species. With the 25 km distance, the landscape patches within the BSPAs are relatively well connected to each other for most landscape types. However, the deep-sea landscape types showed very low connectivity. When using the species-specific approach the analysis showed relatively high connectivity among landscape patches suitable for widespread species with high dispersal abilities such as Baltic telling (*Macoma baltica*). For short-distance dispersers, however, the BSPA network is not well connected. Furthermore, water currents affect dispersal, either inhibiting or enhancing it, and thus the fixed distances in the BALANCE assessment should be seen only as a preliminary “rule of thumb".

The BALANCE analysis also showed that since BSPAs, on average, are relatively large, the main part of the connectivity reflects *within-site connectivity* between landscape patches inside a BSPA, whereas *between-sites connectivity* is much weaker. While between-site connectivity is important for long-distance dispersers, the within-site connectivity is important for short-distance dispersers. In addition, as most of the BSPAs are situated in the coastal areas, the connectivity is very weak across the deeper offshore areas of the Baltic Sea and the network does not support good connectivity for the species inhabiting these areas.

7.3 Current Status of the legal protection and management of the BSPA network

Establishment of an ecologically coherent and well-managed network of Baltic Sea Protected Areas requires relevant legal protection and management measures. Most existing sites lack implemented management plans or other means of site management, and are predominantly aimed to protect birds or terrestrial species. Although many sites enjoy some national protection also in marine areas, it is in most cases not clear what species or habitats within the site are really protected features. Since nearly all BSPAs are also EU Natura 2000 sites, this should ensure that at least Natura 2000 habitats and species are protected. However, since the species and habitats considered in the Habitats Directive only cover a part of the existing biodiversity values in the Baltic Sea, more is needed to create a truly representative and coherent network of MPAs in the Baltic Sea. The HELCOM Lists contain more marine habitats and species than the Natura 2000 Directives and therefore the BSPA network is an important complement Natura 2000.

In order to properly manage a protected area, harmful activities must be controlled and regulated. Figure 7.7 illustrates regulated activities in those BSPAs which are partly or fully managed. For example fishing, harvesting, tourism and recreation can be restricted activities within BSPAs. As already pointed out earlier, some human activities cannot be regulated by the coastal states themselves. For example within EU, Member States have no power to regulate harmful fishing activities by other Member States in their national waters and EEZ. A similar situation occurs, when disturbances from shipping must be regulated – a coastal state has no sovereignty outside its Territorial Waters, although each state is obliged to implement the Joint Work

Programme also beyond. Due to these circumstances it is of outmost importance that HELCOM Contracting Parties work closely together in order to stipulate those international bodies which have the power to regulate harmful fishing activities and shipping at appropriate locations (EU-CFP and IMO). In this regard it must be mentioned that the Baltic Sea area is designated as a Particularly Sensitive Sea Area (PSSA) by IMO, except for Russian waters. At the request of Sweden, IMO designated two of Swedish offshore BSPAs[21] as "areas to be avoided" for environmental protection; all ships with a gross tonnage of 500 or more, should avoid these areas.

7.4 A regional and systematic approach to selecting a representative network of MPAs: an example from the BALANCE project

To enhance the development of the Baltic Sea MPA network, BALANCE has developed and tested a regional, systematic approach to select a representative and coherent network of MPAs in the Baltic Sea. Based on best available data this is the first holistic approach to optimize the Baltic Sea MPA-network, and aims to represent the full range of biodiversity and ecosystem functions in the Baltic Sea and thereby help to fulfil agreed international conventions and agreements such as the Joint Work Programme. At the same time this approach attempts to build on existing MPAs and minimise the cost and impact on other interests. For more details see Liman et al. (2008).

Having been successfully used in other parts of the world, BALANCE introduced the computer-based decision support tool MARXAN (Ball & Possingham, 2000; Possingham et al. 2000) into the Baltic Sea. Such tools are helpful in systematic site selection processes where consideration of large amounts of spatial data and an enormous number of possible combinations of sites is required.

This kind of site selection process should include as much data as possible to ensure that the biodiversity in the region is well represented in the selected MPA-network. Because of the lack of Baltic-wide data on biodiversity, the project relied on the broad scale representation of all benthic marine landscapes present in the region. In addition to that, also reliable spatial data on species and habitats were included. These were cold water corals (only in Skagerrak), Important Bird Areas (IBAs) and haul out sites for grey seals. This site selection exercise is an example, and should be considered an iterative and constantly improving process. Other conservation features should be included when more and better information becomes available.

Conservation targets and principles: The aim was to set the conservation targets in line with both scientific recommendations and existing political agreements. Three scenarios were explored according to three levels of conservation ambition, i.e. 3 scenarios with different minimum levels of benthic marine landscape representation:
1) Representing ≥20% of each marine landscape (recommended minimum level of protection)
2) A lower ambition (≥10%)
3) A higher ambition (≥30%)

In addition to the conservation targets for marine landscapes, targets were also set for the species mentioned above. Moreover, criteria for spatial representation in the region were set to guarantee that the MPA network fulfils some basic principles. One of the main principles was that existing protected areas should be included in the selected network and that new sites should be identified to complement the already designated sites to meet the conservation targets (in this specific case the Natura 2000 Special Areas of Conservation, SACs). Another important principle was that each conservation feature should be represented to its conservation target within each ecologically different sub-region[22] and each country to ensure a certain amount of replication and to guide the distribution of sites spatially i.e. an even distribution between countries. Socio-economic factors[23] and the suitability of sites were also taken into account, meaning that the conservation targets should be met with a

21 Hoburgs Bank and Norra Midsjöbanken

22 HELCOM subregions (Bothnian Bay, Bothnian Bay, Gulf of Finland, Baltic Proper, Kattegat) and Skagerrak.

23 Socio-economic factors in the analysis were oil terminals, harbours, potential ship accident areas, major shipping lanes, recommended shipping routes and human population density.

minimum impact on other interests and that the relative suitability of potential conservation sites should be considered. The size of the selected sites should also reflect the broad scale objective of the exercise, meaning that relatively large sites should be selected for protection of the ecosystem on a regional scale.

Results: The scenario presented here was developed with the aim to demonstrate a systematic approach to selecting sites which represent the broad scale variation in the Baltic Sea. It should therefore be emphasised that the results presented below are only examples of what a representative MPA network in the Baltic Sea could look like given the specific criteria applied in this assessment. The results presented in the figure 7.8 relate to the scenario representing a minimum of 20% of all benthic marine landscapes. To view results of the other scenarios e.g. the 10 and 30% scenarios see Liman et al. (2008).

Figure 7.8 A shows the one set of sites (selected during repeated MARXAN runs) that meets all the above-mentioned conservation targets and principles in the most efficient manner. According to this particular analysis, the area of the additional sites needed, as a complement to the existing sites, to fulfil the recommended 20% representation target, corresponds to approximately three times the existing SACs[24]. The selected network of sites in figure 7.8 A, with its combination of selected and already existing sites, covers an area equivalent to approximately 30% of the entire Baltic Sea water area. This number, however, only relates to the specific analysis criteria applied in this assessment, but give a clear indication of what a representative MPA-network in the Baltic Sea would look like.

Figure 7.8 B shows how frequently different areas were selected in a set of repeated independent MARXAN runs; the more selected, the more important that area is for the conservation target. It also shows the flexibility of including different areas when building an efficient and representative MPA-network. Red colour indicates areas that are crucial to efficiently reach the targets e.g. because they cover species/landscapes that only exist in that specific site or are adjacent to an existing protected area and therefore easy to include by extending an existing site, while yellow indicates areas that are more flexible in the sense that many alternative areas can equally efficiently contribute to meeting the same target. The generally high flexibility in the result arises from the fact that there are only few geographically overlapping conservation features (because of few datasets of landscapes, habitats and species). The suitability of individual planning units, is therefore an important factor determining the spatial selection of sites e.g. threats or conflicts with socio-economic interests (low suitability) or if they are placed adjacent to an existing MPAs (high suitability). If more species and habitat information, and more socio-economic considerations, were included, the targets would be more difficult to reach and flexibility decreased. Moreover, areas of importance for several conservation features would be identified.

This site selection exercise clearly shows that a regional systematic approach to site selection is feasible in a multinational area such as the Baltic Sea Region. If the aim is to establish a representative network, the use of a systematic approach to site selection instead of selecting MPAs site by site is recommended. This maximizes the chance of creating a network that is representative and efficiently contributes to the protection of the entire Baltic Sea ecosystem and at the same time takes socio-economic factors into consideration. The methodology and results presented here should, however, be viewed as a first step in this direction and should be further improved. The quality of the results depends to a large extent on the formulation and agreement of conservation objectives and criteria, and on the data available. More detailed spatial data is the prerequisite for future site-selection analyses.

7.5 Conclusions

Both HELCOM and BALANCE evaluations indicate that the current BSPA network does not fulfil the criteria for an ecologically coherent network. Therefore, for the time being, and with respect to the full implementation of HELCOM Recommendation 15/5, the Joint Work Programme and the BSAP, the BSPA network cannot be considered sufficient to date. In summary:

24 It must be kept in mind that Natura 2000 protection features do not include most of the benthic marine landscapes

- The BSPA network can be considered **adequate** in terms of sizes of the sites, whereas the geographical coverage and distribution of the BSPAs in the current network can not be considered adequate – the network covers less than 10% of the entire Baltic Sea and the proportionate coverage of sites differs significantly between coastal and offshore waters, sub-regions and countries.
- The BSPA network is not **representative** with respect to its representation of species, habitats and benthic marine landscapes. The need to increase representation is, however, most obvious in deep-water areas.
- Replication of species as well as many landscape types is adequate in the current BSPA network. However, hard clay and bedrock landscapes have relatively few replicates. In order to assess replication comprehensively, information on species and habitat distribution must be improved in the BSPA database.
- The BSPA network is relatively well **connected** when it comes to species with long dispersal distances, but it does not sufficiently support connectivity of the short and mid-distance dispersers. Some indications of relatively good within-site connectivity were found in larger sites. Due to gaps in representation in the offshore areas, the network does not support connectivity of the species across larger basins.

Although the BSPA database contains some information on the parameters used to assess the ecological coherence, the information in the database is patchy and therefore it is not possible to undertake a comprehensive assessment based on the current level of information and data.

Ecological coherence can only be reached by better protection of all important features of marine biodiversity in well-managed areas, which is why national protection and management measures are essential and must be reported to HELCOM for further assessments.

The example of the site-selection analysis clearly shows that a regional systematic approach to site selection is indeed feasible in a multinational region such as the Baltic Sea. Such an approach maximizes the chance of creating a network that is representative and coherent and, when well managed, could protect the whole range of biodiversity in the region while considering socio-economic factors at the same time.

7.6 Recommendations and proposed actions to meet the HELCOM 2010 target

The forthcoming implementation process of the MSFD will be of particular importance for the protection of species and habitats within and between the BSPAs, provided that HELCOM will bring these conclusions and the following recommendation into this implementation process. Based on the identified gaps, the following actions are proposed to be carried out by the Contracting States and HELCOM:

Use the BSPA network as one measure to protect the entire ecosystem and the whole range of species, habitats and ecological processes in the region, including the threatened and/or declining species, habitats, biotopes and biotope complexes, and habitat building species.

Designate preferably all marine Natura 2000 sites as BSPAs and designate additional offshore BSPAs of ecological importance.

- Develop and implement management plans, or – where more appropriate measures and routines - for all BSPAs.
- Complete the HELCOM BSPA database with all data required, in particular with data on marine landscapes, species and habitats inside BSPAs in order to:
    - assess how habitats and species are represented and protected in the network
    - assess how important nursery, juvenile, spawning, feeding, moulting and wintering areas of threatened or declining (and important) species are represented and protected in the network
    - assess how rare, unique or representative geological or geomorphological structures or processes are represented and protected in the network.
- Use the marine landscapes, as demonstrated within BALANCE, to protect a wide range of species, habitats and ecological processes, especially when there is a lack of more detailed data.

- Use a regional and systematic approach to site selection to make sure as it maximises the chance of creating a BSPA network that meets the conservation targets in an efficient way and at the same time minimises the impact on other interests.
- Integrate BSPA designation in an overarching spatial planning and management process in combination with other management tools.

7. TABLES

Table 7.1. The history of the designation status of BSPAs.

	1994 (HELCOM Rec. 15/5	2003 (JWP agreed)	2006 Assessment	Actual number of sites (end of 2008)
Designated and/or Managed BSPAs	None	10	78	89

Table 7.2. Country-wise description of number and size of the designated and managed sites in the HELCOM BSPA database as well as information on the marine proportion of the BSPAs.

Country	Number of BSPAs	Total area of BSPAs (km^2)	Proportion protected (%)	Marine proportion of the BSPAs (%)	Marine area (km^2)	Marine proportion of BSPAs in EEZ (%) [a]
Denmark	16	3022	6.8	87.6	2647	19.5
Estonia	5	2560	6.9	63.0	1612	0
Finland	22	6100	7.4	90.4	5512	0
Germany	12	4780	31.5	93.7	4480	54.8.
Latvia	4	1154	4.0	74.8	863	0.1
Lithuania	3	6208	9.5	3.6	223	0
Poland	4	2045	6.9	63.5	1299	0
Russia	2	3427	1.4	7.2	246	0
Sweden	21	6781	4.5	83.9	5687	2.0
Total	89	27405	6.6	82.4	22569	1.2

[a)] Exclusive Economic Zone excl. Territorial Waters.

Table 7.3. Proportion of marine area designated as BSPAs of the total marine area in HELCOM marine sub-regions and the larger sub-regions according to BSPA database

HELCOM 18 Sub-regions	BSPA coverage (%)	Sub-regions	BSPA coverage (%)
The Gulf of Gdansk	20	Baltic Proper	5
The Gulf of Riga	4		
Eastern Gotland Basin	5		
Western Gotland Basin	2		
Southern Baltic Proper	4		
Northern Baltic Proper	5		
Bothnian Bay	3	Bothnian Bay	5
The Quark	18		
Bothnian Sea	4	Bothnian Sea	4
Åland Sea	2		
Archipelago Sea	4		
Gulf of Finland	9	Gulf of Finland	9
Kattegat	8	Kattegat	12
The Sound	14		
Little Belt	4		
Great Belt	11		
Kiel Bay	36		
Bay of Mecklenburg	18		

Table 7.4. Number of species by group in the HELCOM list of threatened and/or declining species and habitats/biotopes of the Baltic Sea area and number of these species reported within the BSPA network and number of these sites. Annex 1 includes a complete list of species, sub-regions where the species is under threat or declining and the number of BSPAs.

Species group	Number of species in the HELCOM list	Number of threatened/declining species within the BSPAs	Number of BSPAs
Algae	8	12	7
Vascular plant	4	1	2
Invertebrates	7	7	4
Fish	23	31	24
Birds	13	24	71
Mammals	4	5	45
Total	59	80	

7. FIGURES

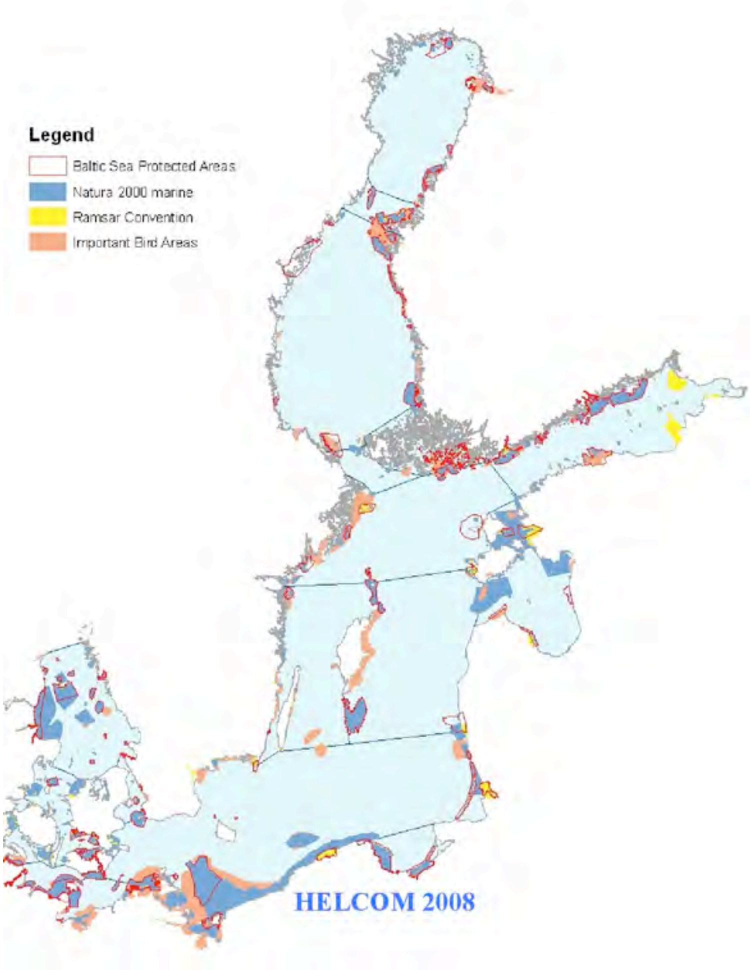


Figure 7.1. Overview of MPAs in the subregions of the Baltic Sea area, as of October 2008. Note that the sites overlap in the order indicated in the legend. Important bird areas are sites proposed by BirdLife International (they have no protection).

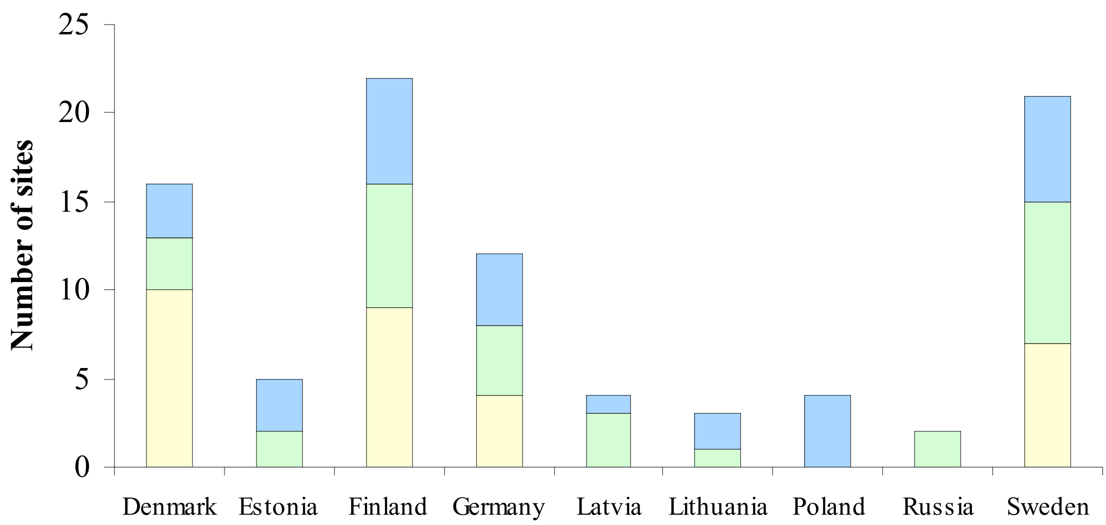


Figure 7.2. The size distribution of BSPAs in the HELCOM Contracting States.

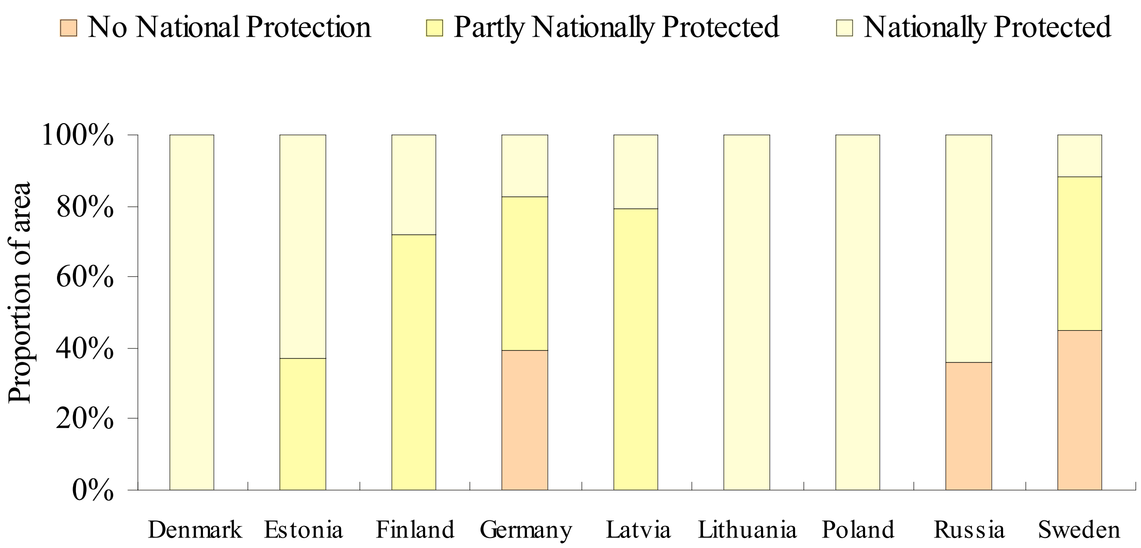


Figure 7.3. The area and number of sites with national legal protection status in the HELCOM Contracting States. The exact area (km^2) is in Table 7.2.

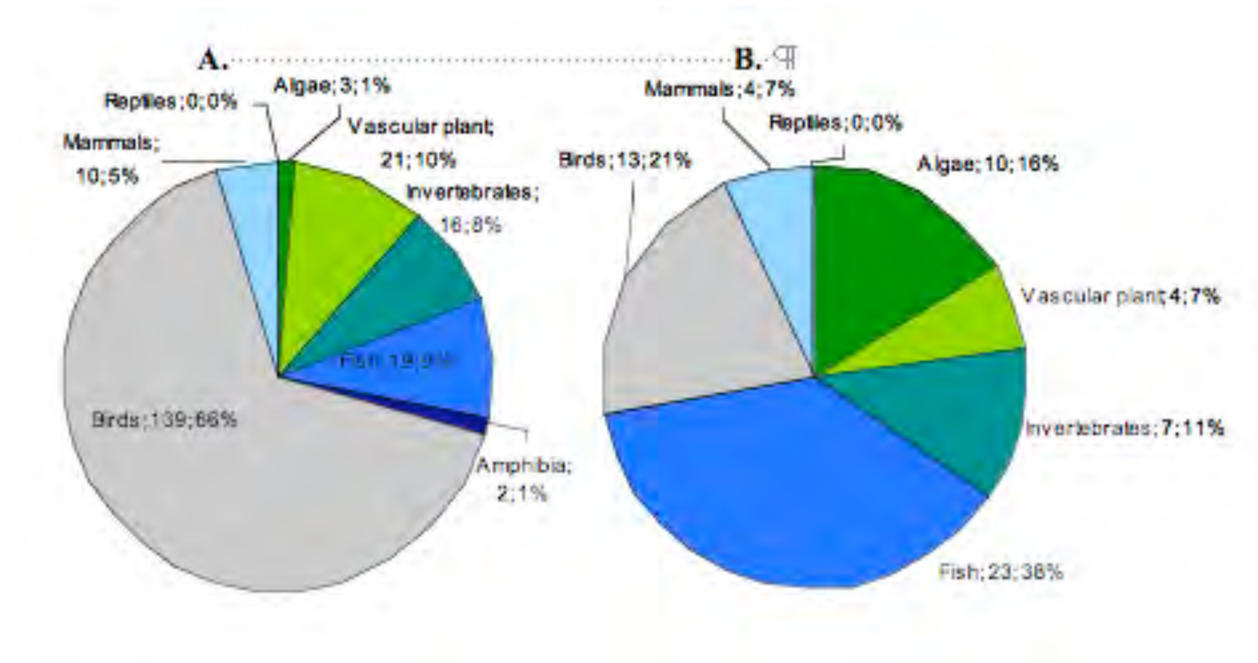


Figure 7.4. Number and percentage of species in the BSPA database. (A) All the species reported within the BSPA network (207 species) and (B) HELCOM red-listed species within the BSPA network (61 species).

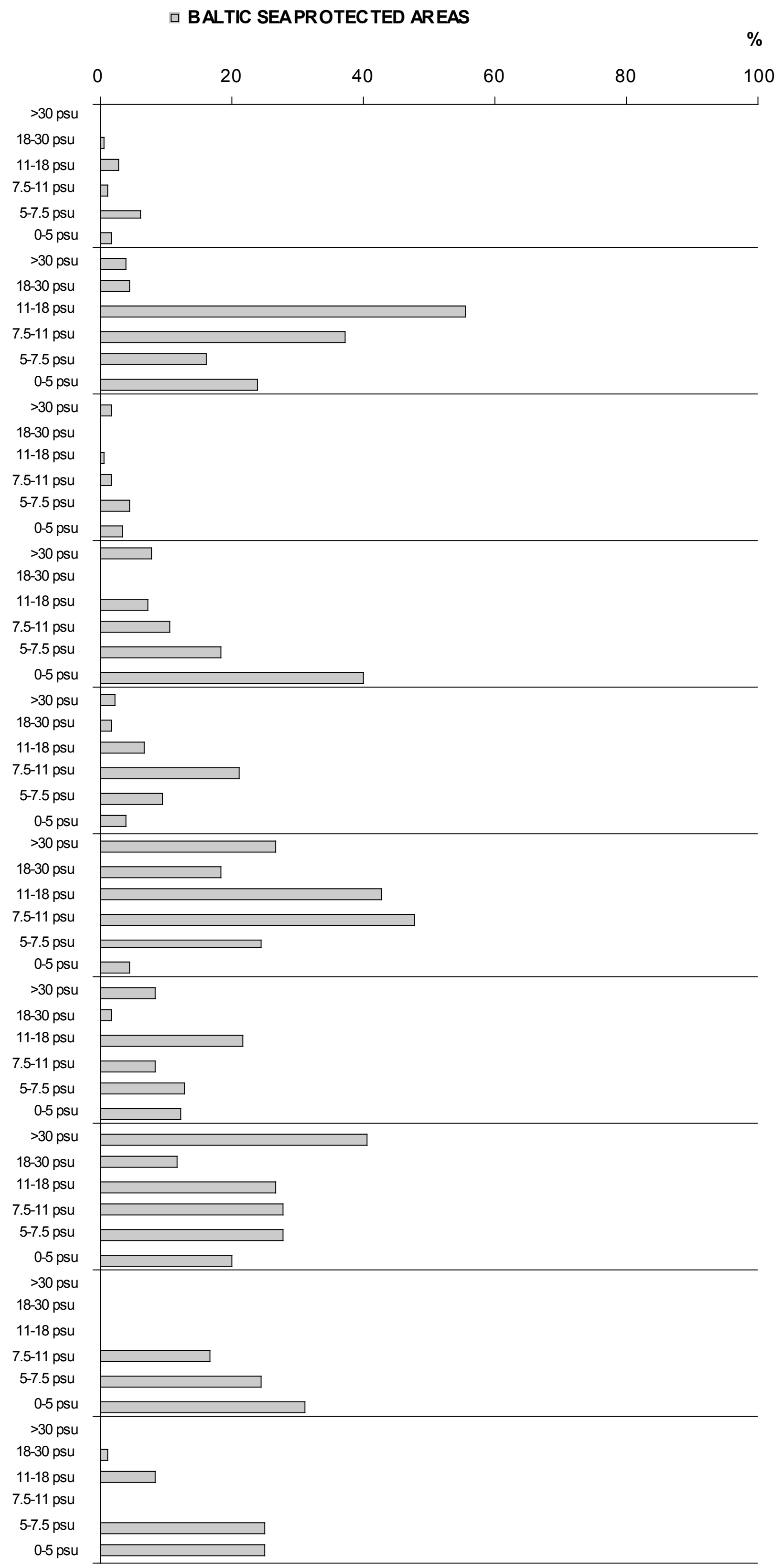


Figure 7.5. Proportion of the 60 benthic marine landscapes represented within BSPAs (horizontal axis). Salinity categories are grouped according to substrate type and photic depths (the vertical axis). (Piekäinen & Korpinen, 2008).

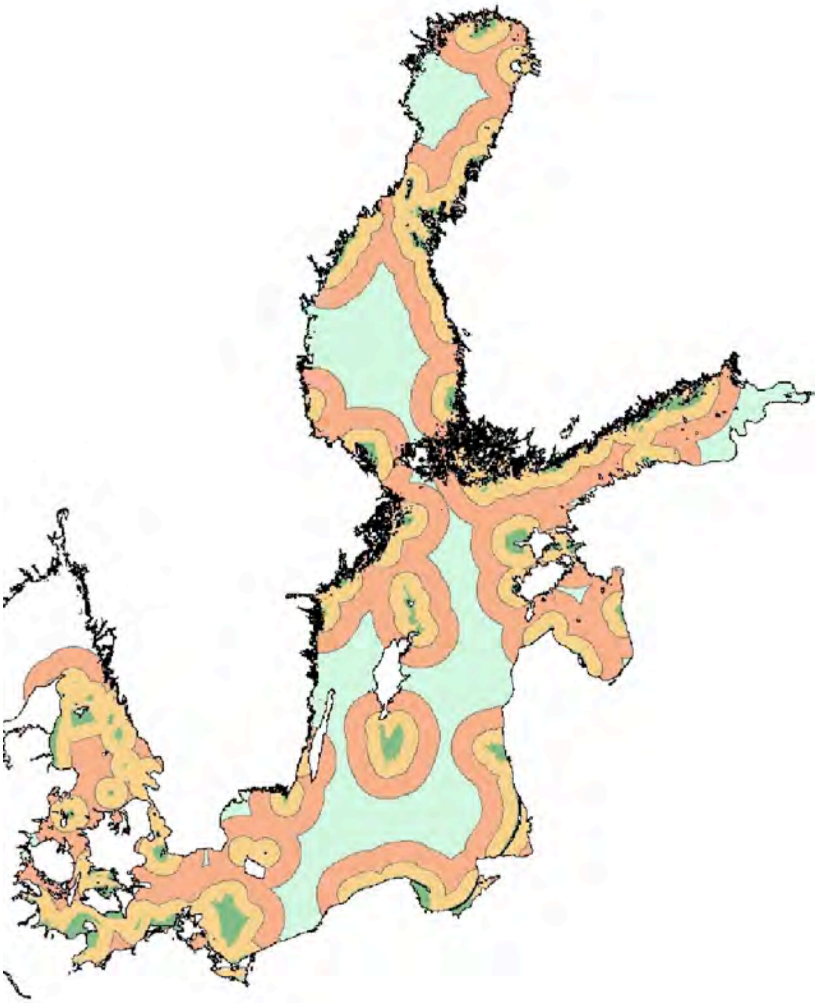


Figure 7.6. BSPAs (in darker green) with 20 km and 50 km buffer zones indicating 40 and 100 km connectivity between the sites.

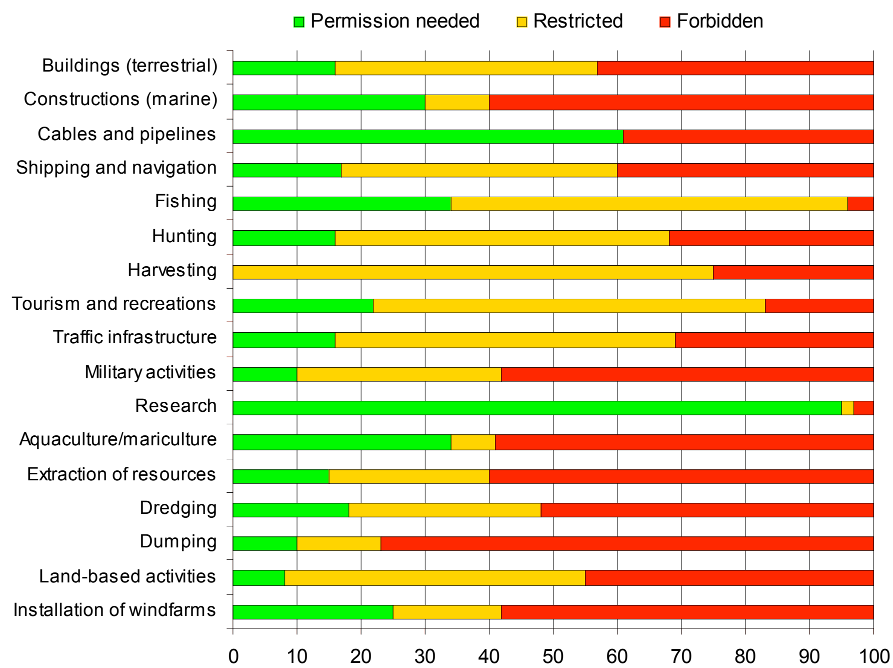


Figure 7.7. Activities forbidden, restricted or requiring permission within BSPAs.

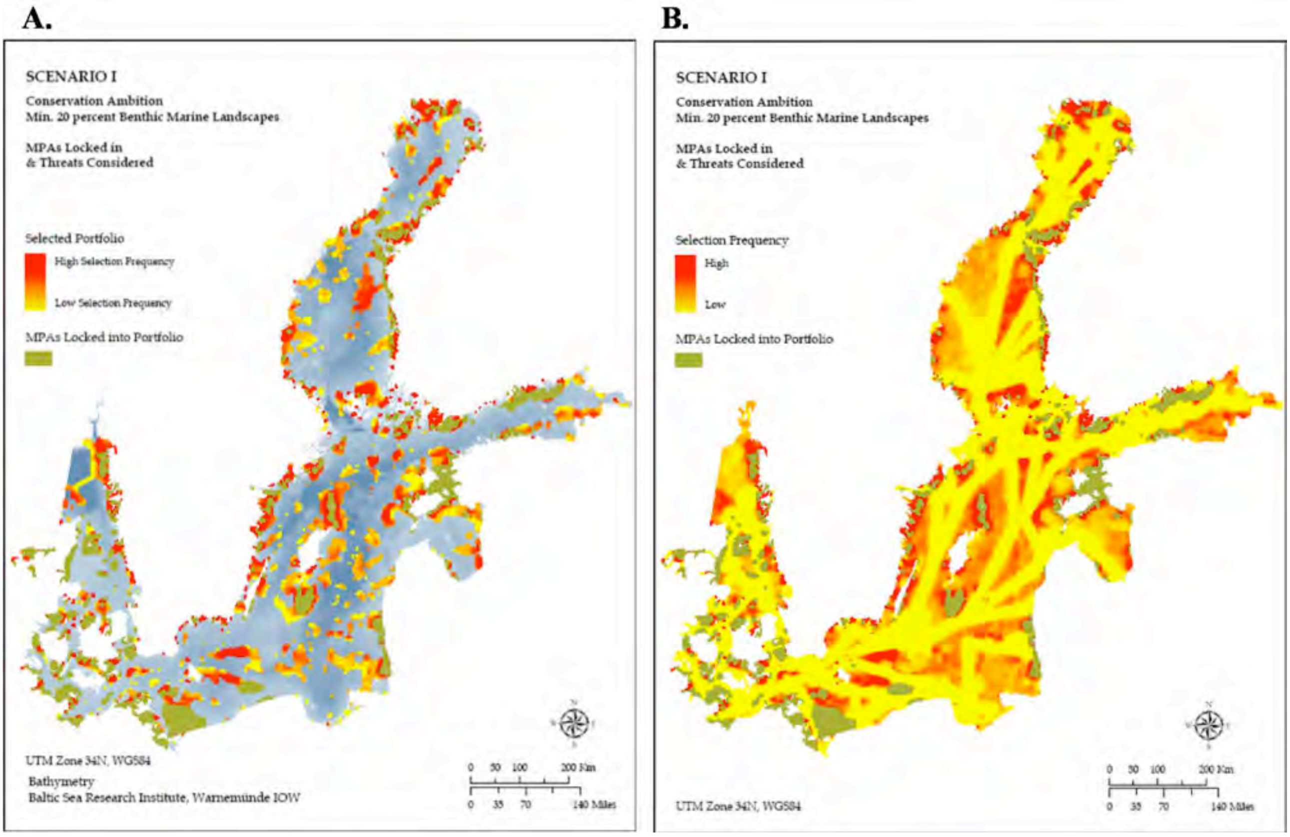


Figure 7.8. A. MARXAN ”best portfolio”. This set of selected areas fits best the chosen targets for the network. B. MARXAN selection frequency. The redder colors indicate areas that were selected more often than others (more yellow), indicating the importance of selecting them to the MPA network. Technical details: The figures reflect targets set to represent a minimum of 20% of all benthic marine landscapes and IBAs, 60% of all Grey Seal haul out sites and 100% of all Cold Water Coral occurrences (60% of the dead structures). The portfolio adds complementary sites to Natura 2000 SACs, using BLM=2.5, stratified targets and a measure of suitability. The selection was done using simulated annealing with iterative improvement using 2 million iterations in 100 runs and a “penalty value” of 1.1 for all features. All targets were met. From: Liman et al. (2008).

7. BOXES

Box 7.1. Natura 2000 network of protected areas in the European Union

Natura 2000 is a network of protected areas legislated by the European Union. This network is based on requirements according to the Birds Directive[1] and the Habitats Directive[2] adopted in 1979 and 1992, respectively. The overall objective of the Natura 2000 Directives is to achieve or maintain favourable conservation status of European biodiversity features. In order to do so each EU Member State must establish a suite of Special Protection Areas (SPAs) for birds and Special Areas of Conservation (SACs) for non-bird species and habitats listed in the annexes to the directives and manage these protected areas appropriately. The mere designation of an SPA and/or an SAC may be insufficient to achieve favourable conservation status. Other species and/or habitat protection measures, in particular management measures, are required. In relation to this is important to mention that BSPAs may protect a wider range of species, habitats, biotopes and natural processes than the Natura 2000 Directives, if the corresponding HELCOM lists are taken into account (HELCOM 2007 b).

1 Council Directive 79/409/EEC on the conservation of wild birds, 2 Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora

Box 7.2. HELCOM objectives and criteria for the assessment of the status and the coherence of the BSPA network.

1. A BSPA should give particular protection to the species, natural habitats and nature types to conserve biological and genetic diversity;

2. it should protect ecological processes and ensure ecological function;

3. it shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

4. The network should protect areas with:

- threatened and/or declining species and habitats
- important species and habitats
- ecological significance
  - − a high proportion of habitats of migratory species
  - − important feeding, breeding, moulting, wintering or resting sites
  - − important nursery, juvenile or spawning areas
  - − a high natural biological productivity of the species or features being represented
- high natural biodiversity
- rare, unique, or representative geological or geomorphological structures or processes.
- high sensitivity.

5. The minimum marine size of a BSPA should be preferably 3000 ha for marine/lagoon parts.

6. The system should be enlarged stepwise by additional areas, preferably purely marine ones.

7. Criteria for the assessment of the ecological coherence*:

Adequacy, representativeness, replication of features, connectivity.

Based on: JWP, HELCOM Rec. 15/5 (incl. guidelines), HELCOM HABITAT 8 (2006).

*According to the EC Habitats Directive, a coherent European ecological network of special areas of conservation (Natura 2000) is composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, and enables the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

CHAPTER 8: SYNTHESIS – TOWARDS A FAVOURABLE CONSERVATION STATUS OF BALTIC SEA BIODIVERSITY

The biodiversity segment of the Baltic Sea Action Plan responds to 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 signatories of the Action Plan, the status of biodiversity as well as of the conservation status need to be regularly evaluated. Hence, the need for development of a harmonised approach to assessing the conservation status was also identified in the BSAP.

This report 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. The synthesis 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.

8.1 Overview of the results

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 last thirty years or so. For the preceding period, frequent monitoring data is only available for a restricted number of biodiversity relevant parameters.

The Baltic Sea is at the same time 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 and Nausch 2003) which in turn have affected the distribution of species and ecosystem structure. The changes in climate thus make it difficult to distinguish natural variability from human induced modification of the Baltic Sea ecosystem. 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.

Signs of change:

- **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, seagrass 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 bladderwrack a decline has also been observed in areas with low disturbance indicating that large-scale hydrological 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 and species diversity. 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 and cyprinids are currently flourishing. Warm summers have also contributed to this development. In some other areas coastal 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 population decline is evident for dunlin, eider and long-tailed duck. The causes behind the decline vary from shipping induced oil spills to fisheries by-catch and habitat decline, depending on the species and their primary habitat.
- **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. 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.** There are new species observed in almost all Baltic Sea communities. 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. 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 potential 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 threatened or declining in the Baltic Sea. The only known extinct species is the Baltic 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.
- **Biotopes.** The coastal biotopes and habitats are largely in an unfavourable conservation status and continue to be under increasing pressure in many sub-regions (HELCOM 1998; HELCOM 2007). Many if not all habitats are being impacted by eutrophication. In addition, physical disturbances such as dredging 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.

With its relatively limited number of species, low genetic variation within species, and few species within important functional groups, the Baltic Sea ecosystem is inherently sensitive to disturbances. 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.

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 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 a slight improvement of the natural smolt production of salmon populations, improvement of seatrout populations in the western Baltic, significant improvement of the smelt stock in the Gulf of Riga, increase of the share of pisciviorous fish and the trophic level of fish communities in some coastal areas.

- **Aquatic vegetation.** In a number of coastal areas of the Baltic Sea, also submerged aquatic vegetation shows signs of recovery after years of deterioration.

These improvements display results of effective protection by restrictions or ban of hunting, reductions in inputs of hazardous substances, protection of important habitats and species and to some extent improvement of water quality. The improvements also show how concerted and inter-sectoral management actions have reverted precarious situations for some selected species in the Baltic Sea to a better status.

The geographic coverage of biodiversity relevant data in the Baltic Sea area is in many cases limiting but a crude overview can be drawn from the status of some of the elements of biodiversity, mainly species and communities addressed in this assessment (Table 8.1). Favourable conservation status of species, taxonomic groups and communities is more prevalent in the northernmost sub-basins of the Baltic Sea. This result is in agreement with the pilot testing of the Biodiversity Assessment Tool BEAT (see chapter 5) and the results of the integrated thematic assessment of eutrophication (chapter 6 and HELCOM 2009).

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.

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 2007 b). The HELCOM integrated thematic assessment of eutrophication reported most of the Baltic Sea as an eutrophication problem area (HELCOM 2009). However, there are also signs of improvement. Slight decrease of nutrient inputs to the Baltic Sea has been recorded between the late 1990s and 2001-2006 and positive trends have been observed in a number of areas concerning nutrient concentrations. 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.
- **Fishing** on the eastern Baltic cod stock 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 (Jackson et al. 2001, 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. The risk that alien species become harmful or invasive increase with other disturbances to the ecosystem, such as changes in the trophic structure by fishing and degradation of water quality or habitats. As an example, in 2006 the American comb jelly *Mnemiopsis leidyi* was first observed in the Kattegat, and by 2007 it had invaded the deep waters of the Baltic Proper and the Bothnian Sea. The species is known to have contributed to the collapse of fish stocks in both the Black and Caspian Seas.
- **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 load of heavy metals and most organic chemicals to the Baltic Sea have decreased since the early 1990s and a reduction of many of these compounds is measurable in the Baltic biota. However, the concentration of certain other 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 and sounding. 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 cause physical disturbance to shallow benthic habitats, they are 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 will 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 bladderwrack, eelgrass, blue mussel and cod. Decreasing ice cover will have a direct impact on ringed seals whose breeding is linked to the ice. Climate change is also likely to exacerbate eutrophication through changes in hydrology and effects of eutrophication on biodiversity. Climate change is thus expected to add considerable stress to the ecosystem 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 2007) (ICES 2008). In coastal areas, physical disturbance, such as construction works and the almost ubiquitous human impact add significant stress to the ecosystem.

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.

8.2 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, and of the need of humans to use the goods and services provided by an ecosystem. Use of ecosystem goods and services should 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.

The results of this assessment disappointingly 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.

The challenge: 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. 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 of nitrogen emissions, risk of major oil spills and increase in 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 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 shores. Moreover, the World Tourism Organization forecasts that increase in tourism will be larger in the Baltic Sea region compared to other regions (COWI 2007).

The actions to combat climate change, such as the proposed requirements by the European Commission to achieve the level of 20% of renewable energy by 2020 (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 parks to be located in the Baltic Sea and an increase of bioenergy production. For example, increased cultivation of energy crops will result in an increase use of currently set aside land and consequently increased nutrient loading due to fertilizer use. The energy targets will also likely be linked to installations of new underwater cables and pipelines. Growing demand for carbon capture and sequestration (CCS) technologies and sites, as has also been put forward by the Commission (Anonymous 2008b), may mean that potential sites will be explored from the Baltic seafloor as well.

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.

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

An important task of 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 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 (Persson 2004). While policy integration is part of the basic EC Treaty (Article 6) and has been called for in a number of high-level policy documents (e.g. UN Conference on Environment and Development 1992), and the Marine Strategy Framework Directive should ensure it (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 day situation where non-environmental policies are commonly adjusted as a response to negative environmental impacts that have already occurred.

For the Baltic Sea biodiversity, marine spatial planning systems will mean a practical manifestation of policy integration. Marine spatial planning 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 such 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 to better integration of planning systems.

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 1994) – but the network is still not ecologically coherent and thus do not wholly fulfill its purpose unless additional protected areas are designated.

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. As presented in this assessment, the network of BSPA is however not ecologically coherent and recommendations on how to fulfill this commitment by 2010 have been outlined in detail (Chapter 7). The recommendations include e.g. designation of additional BSPAs, particularly in offshore areas, and the development and implementation of management plans 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 secure a proper distribution of protected areas that can improve the current network.

Reduction of human pressures

While protected areas can preserve landscapes and habitats of particular importance and protect against resource extraction, this measure must be matched by concurrent efforts to reduce pressures that affect the quality of the water, 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 by HELCOM Recommendation 24/10 (HELCOM 2003) and European Union (EC 2002).

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 the need for an integrated approach to the management of human activities.

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 already practised restoration methods in the Baltic Sea areas 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 providing only 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 (Fonseca et al. 1998, Thom et al. 2005). In the most extreme case of impaired recovery potential, i.e. that of extinctions, transplantations or re-stocking is the only alternative. This is the case for the sturgeon (*Acipenser oxyrinchus*) 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.

Adaptive management

Adaptive management with regular follow-up of implementation and review followed by necessary 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.

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 modelling directed towards selected components of biodiversity.

8.3 Necessary 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 biodiveristy in order to ensure comparability between biodiversity assessments of different Baltic regions. The current assessment has tested the indicator-based Biodiversity Assessment Tool BEAT in a number of case studies (chapter 5). 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 in the BEAT exercise. 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 harbour 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 assessment.

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 applied 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.

8. TABLES

DRAFT Table 8.1. An estimation of favorable (green) conservation status vs. non-favorable (red) conservation status of different elements of biodiversity in the different sub-regions in approximately 2000-2006 based on the information compiled into the assessment report and on expert judgement. NA – Not applicable.

Examples of biodiversity elements	Kattegat and Danish Straits	Southern Baltic Proper	Northern Baltic Proper	Gulf of Riga	Gulf of Finland	Gulf of Bothnia
Harbour porpoise						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				No data	No data	NA
Charophytes						NA?
Pseudocalanus			NA	NA		NA
Acartia						
Temora						NA
Limnocalanus	NA	NA				
Benthic invertebrate communities	NA			NA		

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Annex I: Authors and contributors *(to be checked and amended)*

Chapter 2: Landscapes and habitats	
2.1 Marine landscapes	
Authors: Reker, Johnny	Agency for Spatial and Environmental Planning, Copenhagen, Denmark
Al-hamdani, Zyad	The Geological Surveys of Denmark and Greenland, Copenhagen, Denmark
Contributor: Reijonen, Anu	The Geological Survey of Finland, Espoo, Finland
2.2 Habitats	
Author: Boedeker, Dieter	German Federal Agency for Nature Conservation, Putbus, Germany
Chapter 3: Communities, Coordinator: Pasi Laihonen, Finnish Environment Institute (SYKE)	
3.1 Phytoplankton community	
Author: Järvinen, Marko	Finnish Environment Institute (SYKE), Jyväskylä Office, Finland
Contributors: Edler, Lars	WEAQ, Ängelholm, Sweden
Fleming-Lehtinen, Vivi	Finnish Institute of Marine Research, Helsinki, Finland
Hajdu, Susanna	Department of Systems Ecology, Stockholm University, Sweden
Jaanus, Andres	Estonian Marine Institute, University of Tartu, Estonia
Jurgensone, Iveta	Institute of Aquatic Ecology, Marine Monitoring Center, Riga, Latvia
Kaartokallio, Hermanni	Finnish Institute of Marine Research, Helsinki, Finland
Kauppila, Pirkko	Finnish Environment Institute (SYKE), Helsinki, Finland
Kuuppo, Pirjo	Finnish Environment Institute (SYKE), Helsinki, Finland
Lysiak-Pastuszak, Elzbieta	Institute of Meteorology and Water Management, Gdynia, Poland
Vandepitte, Lene	Flanders Marine Institute, Belgium, Germany
Wasmund, Norbert	Baltic Sea Research Institute, Warnemünde, Germany
3.2 Habitat forming species	
Authors: Martin, Georg	Estonian Marine Institute, University of Tartu, Estonia
Isaeus, Martin	AquaBiota Water Research, Stockholm, Sweden

Torn, Kaire	Estonian Marine Institute, University of Tartu, Estonia
Contributors: Lindblad, Cecilia	Swedish Environmental Protection Agency, Stockholm, Sweden
Möller, Tiia	Estonian Marine Institute, University of Tartu, Estonia
Sandman, Antonia	Stockholm University, Sweden
Wikström, Sofia	AquaBiota Water Research, Stockholm, Sweden
3.3 Zooplankton community	
Authors: Flinkman, Juha	Finnish Institute of Marine Research, Helsinki, Finland
Postel, Lutz	Institut für Ostseeforschung Warnemünde, Sektion Biologie, Rostock-Warnemuende, Germany
3.4 Invertebrate benthic community	
Authors: Norkko, Alf	Finnish Institute of Marine Research, Helsinki, Finland
Villnäs, Anna	Finnish Institute of Marine Research, Helsinki, Finland
3.5 Fish community	
Author: Ojaveer, Henn	Estonian Marine Institute, University of Tartu, Estonia
Contributors: Boedeker, Dieter	German Federal Agency for Nature Conservation, Putbus, Germany
Gessner, Jörn	Leibniz Institute for Freshwater Ecology and Inland Fisheries, Berlin, Germany
Kolman, Ryszard	Inland Fisheries Institute, Olsztyn, Poland
Lappalainen , Antti	Finnish Game and Fisheries Institute, Helsinki, Finland
Roszkowska, Katarzyna	Ministry of Agriculture and Rural Development Fisheries Department, Warzaw, Poland
Vilhunen, Jarmo	HELCOM secretariat, Helsinki, Finland
Chapter 4: Species, Coordinator Anda Ikauniece, Latvian Institute of Aquatic Ecology	
4.1 Harbour porpoise	
Authors: Verfuß , Ursula Katharina	German Oceanographic Museum, Stralsund, Germany
Bräger, Stefan	German Oceanographic Museum, Stralsund, Germany
Dähne, Michael	German Oceanographic Museum, Stralsund, Germany

Benke, Harald	German Oceanographic Museum, Stralsund, Germany
4.2 Seals	
Authors: Härkönen, Tero	Swedish Museum of Natural History, Stockholm, Sweden
Bäcklin, Britt-Marie	Swedish Museum of Natural History, Stockholm, Sweden
Contributors: Björge, Arne	IMR, Norway
Boedeker, Dieter	German Federal Agency for Nature Conservation, Putbus Germany
Halkka, Antti	WWF, Helsini, Finland
Jussi, Ivar	Estonia
Kuklik, Iwona	University of Gdansk, Poland
Kunnasranta, Mervi	Fisheries and Game Research Institute, Helsinki, Finland
Risberg, Per	Swedish Environmental Protection Agency, Stockholm, Sweden
4.3 Birds	
Author: Herrmann, Christof	Agency for Environment, Nature Conservation, and Geology of Mecklenburg-Western Pomerania, Güstrow, Germany
Contributors: Bregnballe, Thomas	National Environmental Research Institute, Aarhus University, Denmark
Dagys, Mindaugas	Institute of Ecology of Vilnius University, Vilnius, Lituania
Eichhorn, Götz	IPHC/DEPE UMR CNRS Strasbourg, France
Elts, Jaanus	Estonian Ornithological Society, Tartu
Fedorov, Vladimir	Baltic Fund for Nature of St. Petersburg Naturalist Society/St. Petersburg State University, Russia
Gregersen, Jens	Horsens, Denmark
Hauff, Peter	Neu Wandrum, Germany
Knief, Wilfried	Staatliche Vogelschutzwarte Schleswig-Holstein, Kiel, Germany
Larsson, Kjell	Dept. of Biology, Gotland University, Visby, Sweden
Larsson, Mikael	Sweden
Larsson, Rolf	Flyet, Jämjö
Lehikoinen, Aleksi	Department of Biological and Environmental Sciences, Helsinki, Finland
Luigujõe, Leho	Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Tartu, Estonia
Mizera, Tadeusz	Agricultural University, Zool. Dept., Poznan, Poland
Nehls, Hans Wolfgang	Rostock
Thorup, Ole	Ribe
Timonen, Sami	North Ostrobothnia Regional Environment Centre, Finland

Volponi, Stefano	Istituto Superiore Ricerca e Protezione Ambientale (ex INFS), Italy
Wieloch, Maria	Ornithological Station MIZ PAS, Gdansk, Poland
Žydelis, Ramūnas	Duke University Marine Laboratory, Beaufort, USA
Chapter 5: Towards indicator-based assessment of the Baltic Sea biodiversity	
Authors: Backer, Hermanni	HELCOM secretariat, Helsinki, Finland
Andersen, Jesper	DHI, Hørsholm, Denmark
Chapter 6: Human pressures	
6.1 Fisheries	
Author: Ojaveer, Henn	Estonian Marine Institute, University of Tartu, Estonia
Contributors: Bräger, Stefan	German Oceanographic Museum, Stralsund, Germany
Herrmann, Christof	Agency for Environment, Natur Conservation, and Geology of Mecklenburg-Western Pomerania, Güstrow, Germany
Verfuß , Ursula Katharina	German Oceanographic Museum, Stralsund, Germany
Vilhunen, Jarmo	HELCOM secretariat, Helsinki, Finland
6.2 Maritime activities	
Authors: Backer, Hermanni	HELCOM secretariat, Helsinki, Finland
Korpinen, Samuli	HELCOM secretariat, Helsinki, Finland
6.3 Physical damage and disturbance	
Authors: Andrulewicz, Eugeniusz	Department of Fisheries Oceanography and Marine Ecology, Gdansk, Poland
Korpinen, Samuli	HELCOM secretariat, Helsinki, Finland
Backer, Hermanni	HELCOM secretariat, Helsinki, Finland
6.4 Recreational activities	
Author: Ulla Li Zweifel	University of Kalmar, Sweden
Contributors: Andrulewicz, Eugeniusz	Department of Fisheries Oceanography and Marine Ecology, Gdansk, Poland

Boedeker, Dieter	German Federal Agency for Nature Conservation, Putbus, Germany
Ikauniece, Anda	Latvian Institute of Aquatic Ecology, Riga, Latvia
Laihonen, Pasi	Finnish Environment Institute (SYKE), Helsinki, Finland
Ojaveer, Henn	Estonian Marine Institute, University of Tartu, Estonia
Reersø Hansen, Lone	Agency for Spatial and Environmental Planning, Copenhagen, Denmark
6.5 Eutrophication	
Author: Laamanen, Maria	HELCOM secretariat, Helsinki, Finland
Andersen, Jesper	DHI, Hørsholm, Denmark
6.6 Hazardous substances	
Authors: Laamanen, Maria	HELCOM secretariat, Helsinki, Finland
Lehtonen, Kari	Finnish Institute of Marine Research, Helsinki, Finland
Mehtonen, Jukka	HELCOM secretariat, Helsinki, Finland
Schiedek, Doris	National Environmental Research Institute, Denmark
6.7 Alien speices	
Author: Leppäkoski, Erkki	Environmental and Marine Biology, Åbo Akademi University, Finland
Laine, Ari, O.	Metsähallitus, Natural Heritage Services, Finland
6.8 Noise pollution	
Authors: Bräger, Stefan	German Oceanographic Museum, Stralsund, Germany
Zweifel, Ulla Li	University of Kalmar, Sweden
Contributors: Koshinski, Sven	Forschungsanstalt der Bundeswehr für Wasserschall und Geophysik (FWG), Kiel, Germany
6.9 Hunting	
Authors: Korpinen, Samuli	HELCOM secretariat, Helsinki, Finland
Herrmann, Christof	Agency for Environment, Natur Conservation, and Geology of Mecklenburg-Western Pomerania, Güstrow
6.10 Future climate change	
Authors:	

Korpinen, Samuli	HELCOM Secretariat
Chapter 7: Status of the network of marine and coastal BSPAs	
Authors: Boedeker, Dieter	German Federal Agency for Nature Conservation, Putbus, Germany
Andersson, Åsa	WWF, Solna, Sweden
Korpinen, Samuli	HELCOM secretariat, Helsinki, Finland
Liman, Anna-Sara	WWF, Solna, Sweden
Paulomäki, Hanna	HELCOM secretariat, Helsinki, Finland
Piekäinen, Henna	Finnish Environment Institute (SYKE), Helsinki, Finland
Wenzel, Christine	Ministry for Agriculture, Environment and rural Areas of the Federal State of Schleswig-Holstein, Germany

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Annex II: List of acronyms and abbreviations

ASCOBANS Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas

BALANCE Baltic Sea Management - Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning (an INTERREG III B project)

BEAT HELCOM Biodiversity Assessment Tool

BSAP Baltic Sea Action Plan

BSPA Baltic Sea Protected Area

CBD Convention on Biological Diversity

CFP Common Fisheries Policy

EAM Ecosystem Approach to Fisheries Management

EEZ Exclusive Economic Zone

GIS Geographic Information System

HELCOM The Helsinki Commission

ICES International Council for the Exploration of the Sea

IMO International Maritime Organization

MPA Marine Protected Area

NAO North Atlantic Oscillation

IUCN International Union for Conservation of Nature

MSFD Marine Strategy Framework Directive

psu practical salinity units

RAC Regional Advisory Council

SAC Special Areas of Conservation

SEA Strategic Environmental Assessment

ANNEX III: Existing habitat or species distribution models in the Baltic Sea area.

Country/Region	Project	Species/habitat	Area (km^2)	Model	Reference	Contact
Baltic Sea	MopoDeco	Blue mussel		DHI	Continuing	Henrik Skov, DHI
Baltic Sea	MopoDeco	Bladder wrack	120 000	Maxent	Continuing	Anna Engdahl, AquaBiota Water Research
Denmark, Kattegat	MAR-COAST	Blue mussel, Trough shell, Razor clam	100 000	DHI	Continuing	Henrik Skov, DHI
Denmark, Kattegat	BALANCE	Macroalgae	3+320	GLM	BALANCE interim report 21	Karsten Dahl
Denmark, Kattegat, Skagerrak	BALANCE	Demersal fish by shores		GRASP	BALANCE interim report 27	Claus R. Sparrevohn.
Great Belt, Denmark	Sund & Bælt AS	Blue mussel	15 000	DHI	Interim report	Flemming Møhlenberg, DHI
Limfjorden, Denmark	Danish counties in Limfjorden	Blue mussel	10 000	DHI	Interim report	Flemming Møhlenberg, DHI
Estonia	BALANCE	Bladder wrack		GRASP	BALANCE interim report 27	Jonne Kotta, EEI
Finland, Archipelago Sea	BALANCE	Bladder wrack		GRASP	BALANCE interim report 27	Anna Lena Nöjd
Latvia	BALANCE	Furcellaria lumbricalis		GRASP	BALANCE interim report 23	Bärbel Müller-Karulis
Lithuania	BALANCE	Furcellaria lumbricalis		GRASP	BALANCE interim report 27	Darius Danuas, Corpi
Poland	Ecosystem approach to marine spatial planning – Polish Marine Areas and the NATURA 2000	Macrophytes, blue mussel	277	GRASP	Continuing	Julia Carlström, AquaBiota Water Research

	network					
Sweden, all coasts	Governmental commission 25	Bladder wrack	81 500	Maxent	Continuing	Anna Engdahl, AquaBiota Water Research
Sweden, Bothnian Sea (Forsmark), Baltic Proper (Oskarshamn)	SKB biosphere project	Functional groups: macroalgae, carnivorous fish, zooplankton-eating fish, filterfeeders, zooplankton	230+180	GRASP	SKB R0750	Ida Carlén, AquaBiota Water Research
Sweden, Finland, Archipelago Sea	BALANCE	Fish recruitment habitats	100	GRASP	BALANCE interim report 27	Göran Sundblad, Swedish Board of Fishery
Sweden, Bothnian Sea, Gräsö	Governmental commission 25	Macrophytes, blue mussel, fish recruitment habitat, benthic macrophauna	730	GRASP	Continuing	Ida Carlén, AquaBiota Water Research
Sweden, Kattegat/Skagerrak	Governmental commission 26	Macroalgae, mussels, lether coral		GRASP, CART	Continuing	Martin Gullström, AquaBiota Water Research Mats Lindergart, Gothenburg University
Sweden, Koster, Skagerrak	Governmental commission 25	Macroalgae, mussels, lether coral		GRASP	Continuing	Martin Gullström, AquaBiota Water Research
Sweden, Kattegat, Skagerrak	Effects on marine windparks on fish (Vindval Fisk)	Laminaria, mussels, several fish species	100+90	GRASP	Continuing	Ida Carlén, AquaBiota Water Research
Sweden, Missjö, Baltic Proper	Governmental commission 25	Macrophytes, blue mussel, benthic macrofauna	18	GRASP	Continuing	Julia Carlström, AquaBiota Water Research
Sweden, Off shore, Baltic Sea	Offshore banks Survey	Macroalgae, mussels	4 200	GRASP	SEPA off-shore report 5817	Sofia Wikström, AquaBiota Water Research
Sweden, Råneå,	Governmental	Macrophytes	350	GRASP	Continuing	Anna Engdahl, AquaBiota

Gulf of Bothnia	commission 25					Water Research
Sweden, Skagerrak	BALANCE	Nephrops	500	GRASP	BALANCE interim report 27	Martin Isaeus, AquaBiota Water Research
Sweden, Skagerrak	Kosterhavet National Park	Lophelia reefs		CART	Internal report for SEPA	Mats Lindegarth, University of Gothenburg
Sweden, Stockholm	SAKU	Bladder wrack		Isaeus 2004	SEPA SAKU	Sandra Wenngren, Metria
Sweden, Stockholm, Askö	PhD Thesis	Macrophytes	640	GRASP	Sandman et al.(in press)	Antonia Sandman, Stockholm University
Sweden, Stockholm, Ornö	PhD Thesis	Bladder wrack	450	Isaeus 2004	Isaeus 2004	Martin Isaeus, AquaBiota Water Research
Sweden/Stockholm	Svenska högarna	Bladder wrack, Epiphytes, Charophytes, Filamentous algae, Detritus, H2S	33	GRASP	Svenska Högarna 2007	Ida Carlén, AquaBiota Water Research
Öresund	Sund & Belt AS	Eelgrass	5 000	DHI	Internal report	Flemming Møhlenberg, DHI
Sweden, Kattegat, Vinga/Fotö	Commission form Regional Council	EUNIS-habitats		CART	Report in Swedish	Mats Lindegarth, University of Gothenburg
Sweden, Kattegat, Marstrand	Commission form Regional Council	EUNIS-habitats		CART	To be started	Mats Lindegarth, University of Gothenburg

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Svenska högarna 2007, Isæus, M., I. Carlén, C. Wibjörn and S. Hallén, Marinbiologisk kartläggning och naturvärdesbedömning.