Options for Delivering Ecosystem-based Marine Management

The Baltic Sea: Additional information on status of threatened ecological characteristics relevant to the Marine Strategy Framework Directive

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ODEMM Partners

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The Baltic Sea: Background Information of Current Status

Regional Sea description

The status of habitats and species occurring throughout the Baltic Sea is generally well described. As a heavily exploited resource, the Baltic Sea supports 18 of the 20 sectors identified within the ODEMM project, each of which contributes to the current status of its ecological components throughout the region (see Koss et al. 2011 (www.liv.ac.uk/odemm/outputs for a description of sectors). Sectors not present on the region are water desalination and carbon sequestration.

The Baltic Sea is a brackish shallow sea of approximately 377,000km$_2$. Average water depth is 55 m, although in small areas can reach over 450 m. Bounded by the Scandinavian Peninsula, the mainland of Europe and the Danish Islands, the Baltic Sea is connected to the Atlantic Ocean only via the small entrances of the Sound and the Belt Sea (Figure 1). Water exchange is extremely limited and can remain in the Baltic for up to 30 yr prior to exchange resulting in a highly eutrophic marine environment with substantial areas of oxygen depletion throughout.

The Baltic Sea is surrounded by Norway, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany, of which eight are EU Member States. The Baltic Sea region hosts one- fifth of the EU's population, but has a lower population density than the EU as a whole (EU 2010). The recent Communication Concerning the European Union Strategy for the Baltic Sea Region (EU 2010) highlighted current challenges for the region, two of which are: enabling a sustainable environment, and enhancing the region's prosperity. These two challenges are in juxtapose, as increasing economic gains could come at a cost to the Baltic Sea's marine environment.

It is currently evident in the Baltic Sea region that human activities, associated with economic gains, are causing widespread pressures to marine ecosystems. For example, excess nutrients entering the marine environment, from land based industry and agriculture, is causing eutrophication and algal blooms (EU 2010). Overfishing, land-based pollution, rising sea temperatures, the presence of hazardous compounds and adapting to climate change are causing widespread impacts to leisure activities and small-scale commercial use across the region (EU 2010).

However, the Baltic Sea region has experienced economic prosperity, and the highest GDP growth in the EU, since the late 1990's (EU 2010). It is important to note that there are large disparities within the Baltic Sea Region with a clear east/west divide, with the west being more prosperous than the east (EU 2010). Much of the west Baltic Sea region's prosperity is due to increased labour productivity and innovation. This prosperity was destabilised during the recent global financial crisis (EU 2010). It is hoped through future economic stabilisation and regional support for development, that the Baltic Sea region will regain high GDP growth (EU 2010).

The Baltic Regional Sea east/west divide poses socio-political and economic issues of which the Strategy for the Baltic Sea Region seeks to address. This strategy is an attempt to bridge the divide by addressing environmental, economic, social and cultural issues and create more effective co-ordination of activities. This strategy proposes that with better intra-regional communication, that other directives and policies, such as the MSFD, will be adequately addressed.

Figure 1. The Baltic Sea and surrounding countries. Shown are EU Member States and non-Member States and sub-regional sea areas. Map by HELCOM (2010).

Availability of Information: Regional Summary

The Baltic Sea Member States are well placed to undertake their Initial Assessment obligations (Article 8, Directive 2008/56/EC) in which they must assess the current environmental status of the Baltic Sea waters and the environmental impact of human activities by 2020. The Helsinki Commission (HELCOM) leads a coordinated effort of systematic and standardised collection of environmental data from each Member State and Research Institutes in the Baltic Sea region (www.helsinki.fi). Information is available for all ecological characteristics outlined in the MSFD (Annex III, Table 1, Directive 2008/56/EC) and a summary of this information is presented below (more detailed descriptions of this data are available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data).

For those descriptors requiring a pressure assessment approach to evaluate GES, additional information is needed that describes the extent and frequency of the pressures from specific sectors and their impacts on ecological characteristic(s) (e.g. Marine Litter and Underwater Noise pressure and impact effects on ecological characteristics). Much of the information required to undertake a pressure assessment is widely available for the Baltic Sea region; for example, detailed maps of the spatial distribution of marine sectors (e.g. aquaculture facilities) can be downloaded from the HELCOM website in a geo-referenced format. The frequency and impact of specific pressures and the resilience of habitats and species characteristic of the region is also well documented in published literature (i.e. journal articles). Where information was unavailable, expert judgement by ODEMM partners in the Regional Sea and wider European partnership was used to evaluate the frequency and impact of pressures and habitat/species resilience and drew on published literature from surrounding regions.

The primary areas of concern and likelihood of failure to achieve GES for each descriptor in the Baltic Sea were identified (Table 1). Of the 16 ecological characteristics listed in Annex III of the MSFD as recommended for assessment, 50% of those are currently considered either in poor or threatened status using a combination of assessment criteria under the Habitats Directive (HD), Water Framework Directive (WFD), HELCOM and ICES guidance. Not all species or habitats within each characteristic type are in poor or threatened status nor do all indicators available for a given species or habitat indicate poor/inadequate status. However, problems were identified for all GES Descriptors (Table 1) due to the contribution of poor or threatened ecological characteristic(s) to multiple GES descriptors (e.g. marine mammals contribute to the assessment of GES descriptors: Biodiversity, Food webs and Habitat Directive species).

Available status information indicated that several ecological characteristics are currently threatened. These include: nutrients and oxygen content in the near-bottom layers, predominant and listed habitats, fish (listed and commercial species), bottom flora and fauna, plankton, marine mammals and seabirds. Status information was unavailable for

temperature, salinity, non-indigenous invasive species, and pH/pCO2 but could be described using trend information was available. Topography/bathymetry is the only component that cannot be described using status and/or trend information.

Where status and trend information was not appropriate to evaluate a GES descriptor, a pressure assessment was used. Following the approach and criteria developed within ODEMM, several threats to the environment arising from human activities were identified. Those sectors which were considered as contributing pressures that could be detrimental to the marine environment (ecological characteristic(s) or achievement of GES) included Agriculture, Coastal Infrastructure, Fishing, Shipping and Waste-water treatment. Assessment of the contribution of each sector to current status or the highest threat to the marine environment and its components will be evaluated in later ODEMM work packages.

Table 1**.** A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the Baltic Sea. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (see Chapter 2 in Deliverable 1). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex 5 of ODEMM Deliverable 1.

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	Yes	Increased dinoflagellate and cyanobacteria blooms, increases in Chl-*a* (a proxy for phytoplankton)	Moderate	Moderate
1b. Fish	Yes	Some stocks outside safe biological limits (high fishing mortality) and declining commercial catches	Moderate	High
1c. Marine Mammals	Yes	Several species under severe threat of extinction within the next 10 yr and the Harbour porpoise is critically endangered (IUCN Redlist)	Moderate	High
1d. Seabirds	Yes	Stellar's Eider is a vulnerable species (IUCN Redlist) and several other species are in decline in terms of population (breeding) size	Moderate	High
1e. Predominant Habitats	Yes	The highly eutrophic conditions commonly occurring threaten many of the predominant habitats	High	High
2. Non-indigenous species (NIS)*	Yes	There are several invasive species in the Baltic Sea that are increasing in abundance and rapidly expanding their range.	High	High
3. Commercial fish and shellfish	Yes	Several species are currently in poor condition and outside safe biological limits (e.g. cod and salmon)	High	Moderate-High
4. Food webs	Yes	Alterations in the dominance of plankton species and declines in the distribution and population size of several top predators	High	High
5. Eutrophication*	Yes	Widespread eutrophication throughout the region resulting in high-biomass algal blooms, oxygen deficits and mortality events	High	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, fishing, coastal infrastructure, shipping and waste water treatment contribute widespread and persistent pressures that have detrimental effects on several aspects of the Baltic Sea ecosystem	High	Moderate
7. Hydrographic conditions*	Yes	Widespread increases in Sea surface/bottom temperatures (SST/SBT) coupled with increasing acidification (pH) and oxygen deficiencies	Not assessed	Not assessed
8. Contaminants	Yes	The concentration of some metals (e.g. Mercury and Cadmium) has increased but are restricted to localised areas	Moderate-High	High
9. Fish and Shellfish Contamination	Yes	The concentration of metals in bivalve mollusc, fish and seabird species has increased, but vary among sub-regions	Moderate	Moderate-High
10. Marine Litter*	Yes	The concentration of microplastic has increased throughout the region. In some regions, over 12,000kg/yr/500m of beach has been removed	High	Moderate
11. Energy (Underwater noise)*	Yes	Trends indicate an increase in shipping and renewable energy activities leading to increased underwater noise throughout the region	Moderate-High	Moderate
12a. Habitats Directive Habitats	Yes	81% of the habitats listed are currently in unfavourable condition for at least one criterion	Moderate	Moderate
12.b Habitats Directive Species	Yes	50% of the species listed are currently in unfavourable condition for at least one criterion	Moderate	High

Overview of the Baltic Sea: Currently threatened ecological characteristics

Poor or threatened characteristics

Of the 16 ecological characteristics listed in Annex III of the MSFD as recommended for assessment, 44% (7) are currently considered either in poor or threatened status using a combination of assessment criteria under the Habitats Directive (HD), Water Framework Directive (WFD), HELCOM and ICES guidance.

Not all species or habitats within each characteristic type are in poor or threatened status nor do all indicators available for a given species or habitat indicate poor/inadequate status. For example, the Harbour porpoise is considered to have the Least Concern status (according to the IUCN Red List categories and Criteria) in ICES sub-divisions 22-23 and Critically Endangered status in ICES sub-divisions 24-32.

Current threatened characteristics within the Baltic Sea include nutrients and oxygen content in the near-bottom layers, predominant and listed habitats, fish (listed and commercial species), bottom flora and fauna, marine mammals and seabirds. Regional examples of specific species or habitat types are shown in Table 2. Of the remaining eight characteristics, status information is unavailable and of those, a further six can be described using trend information. Trend data is available for temperature, salinity, non-native species, pH/pCO_2 and plankton. Topography/bathymetry is the only component that cannot be described using status and/or trend information.

Fish Species (Commercial and Non-commercial species)

Information was collected on 10 commercial species and 3 non-commercial species (perch, roach and zander) exploited in the coastal waters of Baltic Sea (Table 3). Status information was available for 4 spp. (cod, herring, sprat and salmon) with each evaluated using Fishing Mortality (F) as the primary indicator (ICES, 2009). Assessments were undertaken at a sub-regional level and complicated by the use of different reference points i.e., Maximum Sustainable Yield (MSY; cod, herring, salmon) or Precautionary (PA; sprat, herring). All 4 spp. were classified as being in poor or threatened status in at least one or more sub-regions. A further 6 spp. are recorded within the Baltic Sea region (brill, dab, flounder, plaice, turbot and sea trout), however, no indicator information is available for these species

Table 2. Baltic Sea Summary of ecosystem components (and species) currently assessed as below Favourable Conservation Status (FCS), Good Ecological Status (GEcS) or Threatened (IUCN criteria). In some cases, there are multiple indicators available for each component e.g., Fish – indicators include SSB, Population size, Habitat, Future Prospects, and Overall Assessment.

Fish	Predominant Habitat	Bottom flora and fauna	Seabirds	Marine Mammals	Nutrients and Oxygen
Cod	Deep sea bed	Fucus spp.	Stellar's Eider	Baltic ringed seal	Oxygen (near-bottom)
Herring		*Zostera marina*		Harbour porpoise	Nitrogen
Sprat		Zoobenthos			Phosphorus
Atlantic Salmon					

Table 3. Baltic Sea Fish species currently considered as being in poor or threatened status evaluated using the indicator Fishing Mortality. Where species status is regionally variable, sub-regions in which status is classified as good are also shown.

Fish Species (Common name)	Indicator	Trend	Status	Sub-Region (ICES Grid)
Cod	F_{msy}	Fluctuating	Poor	SD22-24
Cod	F_{msy}	Increasing	Good	SD25-32
Herring	F_{msy}	Fluctuating	Poor (outside safe biological limits)	SD22-29, 32
Herring	F_{msy}	Stable	Poor (outside safe biological limits)	SD28.1
Herring	F_{pa}	Stable	Good	SD30
Sprat	F_{pa}	Decreasing	Poor (outside safe biological limits)	SD22-32
Salmon	F_{msy}	Decreasing	Poor*	SD22-31

*Salmon F_{msy} estimated from smolt production relative to the potential smolt production capacity (PSPC) on a river-by-river basis.

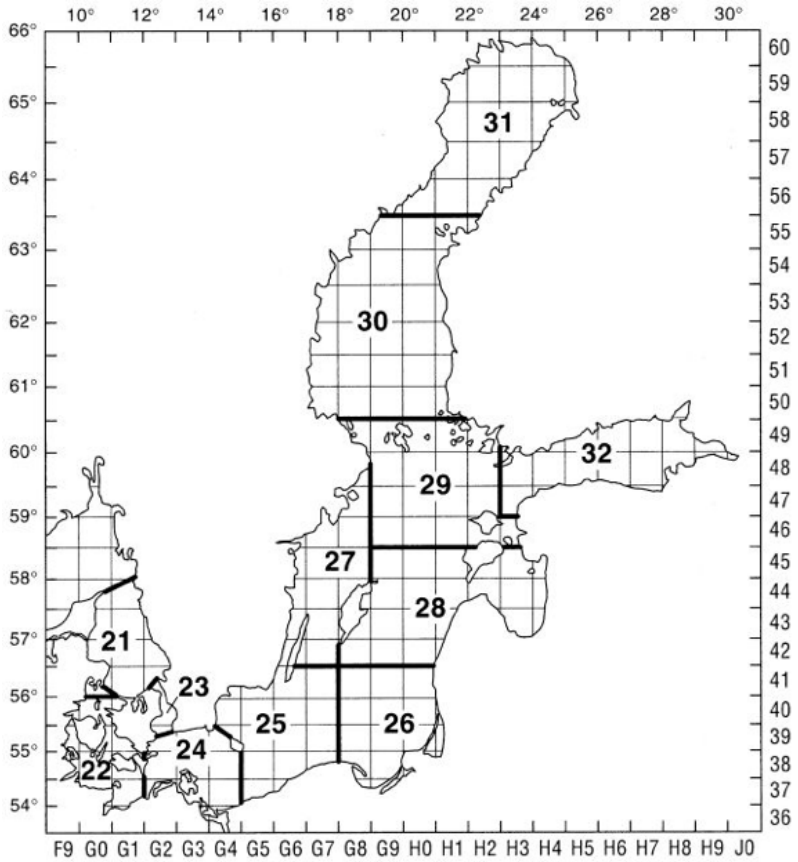

Figure 2. ICES Sub-divisions of the Baltic Sea (redrawn with permission, HELCOM).

Predominant and Listed Habitats

The Baltic Sea is comprised mainly of soft bottoms but there are also areas with littoral rock or hard substrate, especially in the northern part of the sea[1]. Almost entirely deep-sea habitats are anoxic (Zweifel & Laamanen, 2009). The Baltic Sea habitats have been assessed by HELCOM (HELCOM Red list 1998). This classification system covers most Baltic underwater habitats, but the habitat classes are mainly defined by substrate descriptions and do not describe the biology at a level of detail. Moreover, HELCOM has conducted an assessment of habitats/biotopes in 2007 using own and Habitat Directive classification. There are now a working group under HELCOM developing an international habitat classification system (EUNIS classification) for the Baltic Sea by the year 2011[2]. As such, status assessment information of EUNIS habitats is only available for deep-sea predominant habitat. Assessed using descriptions of zoobenthos distribution and abundance, the deep-sea habitat is considered to be in poor (bad) status using criteria described in the Water Framework Directive (Zweifel & Laamanen, 2009; Baltic Sea Environment Proceedings 115B, 2009). The pelagic water column has also been evaluated but using trend information describing the abundance/biomass of copepods. Long-term trends indicate copepod populations are stable (Zweifel & Laamanen, 2009; Baltic Sea Environment Proceedings 115B, 2009). There are numerous listed habitats within the Baltic Sea, and 16 of these are threatened under both regional and EU legislative criteria.

Marine Mammals and Reptiles

Status or status and trend assessments using three indicators have been undertaken for four species of marine mammals in the Baltic Sea (see also listed species). No reptiles e.g., turtles, have been recorded for the region. Indicators include (1) Population Size, (2) Population Condition, and (3) Species Distribution. Commonly occurring species include the Baltic ringed seal (*Phoca hispida botnica*), grey seal (*Halichoerus grypus*), Baltic harbour seal (*Phoca vitulina*), and Harbour porpoise (*Phocoena phocoena*).

Two of these species are currently classified as of concern under the IUCN redlist criteria, categorised as either Near threatened (NT) or Critically endangered (CR) (Table 4) with neither species are showing signs of recovery (Table X).

Table 4. Unfavourable conservation status species in the Baltic Sea under the IUCN Redlist criteria.

Marine Mammals	Failing Indicator	Status	Trend	Region (Sub region)
Baltic ringed seal	Population condition	Near Threatened (NT)	Stable or decreasing	Gulf of Bothnia; Archipelago Sea; Gulf of Finland; Gulf of Riga
Harbour porpoise	Population condition	Critically Endangered (CR)	Unknown	Southern and eastern Baltic Sea (ICES SD 24-32)

Seabirds

There is considerable diversity of seabirds found throughout the European Union, many of which listed as species for conservation under the Birds Directive (Council Directive 2009/147/EC). Considerable public interest coupled with the legislative protection afforded to many bird species has resulted in information describing the status (and trends) of those species being widely available. A comprehensive overview of the status of both individual species and the assemblage of birds within the European Union is reported in *Birds in the EU: A status assessment* (Birdlife International 2004).

Of the 453 terrestrial and marine species listed in that report, seven species are classified as being in unfavourable conservation status as evaluated using estimates of the indicator *breeding population size*. Trend information is also available describing a further nine species; three of which exhibit a declining trend in either breeding population size or population size. Seabird species classified as being in unfavourable status are shown in Table 5 below.

Table 5. Unfavourable conservation status species and population size trends in the Baltic Sea. Shaded rows indicate region-specific species demonstrating declining trends but which are not currently assessed as being in poor status.

[1] Leth et al. (2008). Balance project Technical Summary report. pp 46

[2] HELCOM Red List Biotopes 1/2010. Workshop for the Biotopes Experts of the Project for Completing the HELCOM Red List of Species and Habitats/Biotopes (2010)

Seabird species (Common name)	Scientific Name	Trend
Petrel	*Pterodroma* spp.	N/A
Shearwater	*Puffinus* spp.	N/A
Storm-petrel	*Pelagodroma* spp. *Hydrobates* spp. *Oceanodroma* spp.	N/A
Diver spp.	*Gavia* spp.	Stable
Shelduck	*Tadoma* spp.	N/A
Stellar's Eider	*Polysticta* sp.	Decline
Tern	*Sterna* spp.	Decline
Dunlin*	*Calidris alpina*	Severe decline
Eider↯	*Somateria spp.*	Severe decline
Long-tailed duck↯	*Clangula hyemalis*	Decline
All spp. (assemblage)	**Unfavourable**	Decline

Source: Birdlife International 2004 Birds in the EU: A status assessment.

** indicator is breeding population size*

↯ indicator is population size.

Benthic flora and fauna

Traditionally, there has been little information describing the regional extent, condition and distribution of benthic flora and fauna; primarily due to the difficulties (and prohibitive cost) associated with sampling large areas of marine habitats. In recent years, there has been considerable focus on the assessment of benthic communities and species in the Baltic Sea , however, here we will associate benthic species with a predominant habitat. Habitats (e.g., biotopes) are commonly differentiated or described by an individual or suite of characteristic species (e.g., EUNIS classification). Therefore, the distribution of habitats may be used as a proxy in lieu of relevant indicators to describe the status of marine benthic flora and fauna (see predominant habitats above).

Status and trend information is available for two groups of bottom flora and fauna in the Baltic Sea. These are: (1) Vascular plants (e.g., eelgrass), and (2) Invertebrates (e.g., molluscs, crustacean and chrysomelids). Following WFD assessment criteria, both groups are classified as being in moderate or poor status and a declining trend in the indicators: depth distribution and diversity (Zweifel & Laamanen, 2009; Baltic Sea Environment Proceedings 115B, 2009). Factors threatening the decline of these species include nutrients and oxygen, eutrophication, fishing, aquaculture, shipping, coastal infrastructure and non-renewable energy (oil & gas).

Nutrients and oxygen

Concentrations (mg l^{-1}) of dissolved nitrogen (DIN) and phosphorus (DIP) in the Baltic Sea have steadily decreased as Member States have tried to curb discharges. This target has, in most part been largely met for phosphorus, but not for nitrogen (HELCOM, 2010). However, application of the one out-all out (precautionary) approach results in the status assessment of DIN/TN and DIP/TP indicators as poor. For example, total nitrogen (TN) has increased in some regions (e.g., Gulf of Finland) and decreased in others (e.g., Baltic proper, Danish Straits and Gulf of Riga). Following a precautionary approach, status is therefore classified as poor (WFD).

New areas of hypoxia (dissolved oxygen concentration below 2mg l^{-1}) are being observed globally (Chan *et al.* 2008; Greenwood *et al.* 2010) and are predicted to have introduced 'dead zones' which affects more than 245,000 km^2 of marine ecosystems worldwide (Diaz and Rosenberg, 2008). The Baltic Sea, large areas of the deep-sea habitat are anoxic and light penetration is greatly limited restricting the growth of algae and other plants. The absence of photosynthesising plants leads to little or no dissolved oxygen in the near-bottom layers of the water column and results in a total collapse of the entire ecosystem in those areas. Estimates of oxygen concentrations (DO) are generally highly variable, but values in near-bottom layers commonly reach below the recommended threshold of 3.5 mg l^{-1} (Baltic Sea Environment Proceedings 115B, 2009). Dissolved oxygen concentration is classified as poor under the several legislative criteria including the EU Nitrates Directive (91/676/EEC) and EU Integrated Pollution Prevention and Control (IPCC) Directive (2008/1/EC).

References

All references are available for download from the ODEMM metadatabase (www.liv.ac.uk/outputs/data.html)

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