HELCOM core indicator report
July 2017

State of the soft-bottom macrofauna community

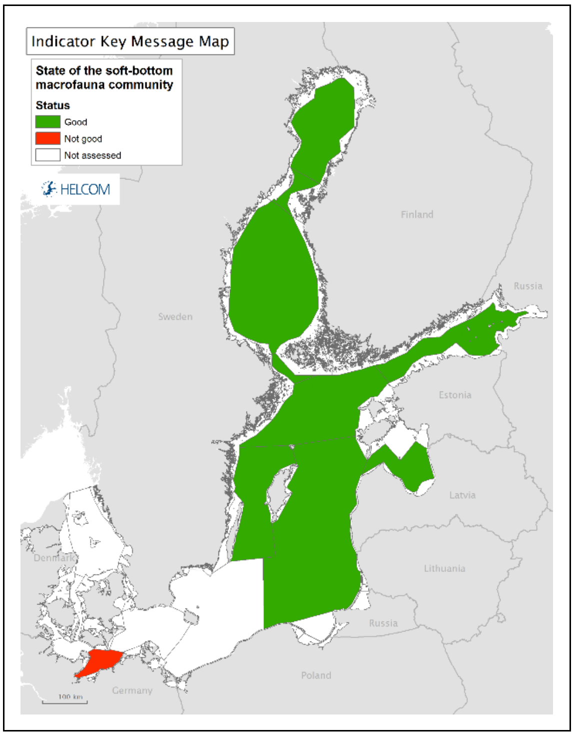
Key Message

The indicator and some of its associated threshold values are still being tested in some countries and may be further developed in HELCOM as a result of the outcome of the testing, or the results may show that the indicator is not suitable for use in a specific sub-basin. The results should thus to be considered as intermediate.

The indicator evaluates the status of the soft-bottom macrofauna community above the permanent halocline in the open sea areas of the Baltic Sea. The current assessment result shows good status in most of the evaluated assessment units.

The indicator is not used in coastal areas which are assessed by national methods or in areas below the halocline which are assessed using the Oxygen debt indicator. The indicator takes into account the relative proportion of sensitive and tolerant species, as well as species richness and abundance.

The current evaluation spans the years 2011-2015, and is based on monitoring data reported by the Contracting Parties of HELCOM. The status of the indicator is good in all assessed sub-basins, except the Bay of Mecklenburg.



Key message figure 1: Status assessment results based evaluation of the indicator 'State of the soft-bottom macrofauna community'. The assessment is carried out using Scale 4 HELCOM assessment units (defined in the [HELCOM Monitoring and Assessment Strategy Annex 4](#)) so that the indicator is only applicable in the open sea assessment units. National indicators are used to assess the coastal assessment units.

The confidence of the indicator evaluation varies between the sub-basins. The spatial representativity of the data is low in Northern Baltic Proper, Gulf of Finland and Eastern and Western Gotland Basins.

The indicator is applicable in the open sea waters of all countries bordering the Baltic Sea but operational only in the evaluated areas due to the lack of threshold values in some of the assessment units.

Relevance of the core indicator

Soft-sediment macrofauna species in the Baltic Sea include animals such as clams, mussels, worms and crustaceans. The animals live on the seafloor as well as burrowed into the soft sediments, thus forming an important link between the sediment and the water column. Soft-sediment macrofauna also forms an important link in the marine food web by constituting an important food source for other animals such as fish and water birds, as well as acting as predators and decomposers.

This indicator evaluates the status of the environment through an index developed to show changes in the relative abundance of sensitive and tolerant species as well as the diversity of the community in soft sediments.

Policy relevance of the core indicator

	BSAP Segment and Objectives	MSFD Descriptors and Criteria
Primary link	Biodiversity • Thriving and balanced communities of plants and animals	D6 Sea-floor integrity D6C5 The extent of adverse effects from anthropogenic pressures on the condition of the habitat type, including alteration to its biotic and abiotic structure and its functions (e.g. its typical species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species), does not exceed a specified proportion of the natural extent of the habitat type in the assessment area. D5 Eutrophication D5C8 The species composition and relative abundance of macrofaunal communities, achieve values that indicate that there is no adverse effect due to nutrient and organic enrichment
Secondary link		D4 Food-web D4C1 The diversity (species composition and their relative abundance) of the trophic guild is not adversely affected due to anthropogenic pressures

Cite this indicator

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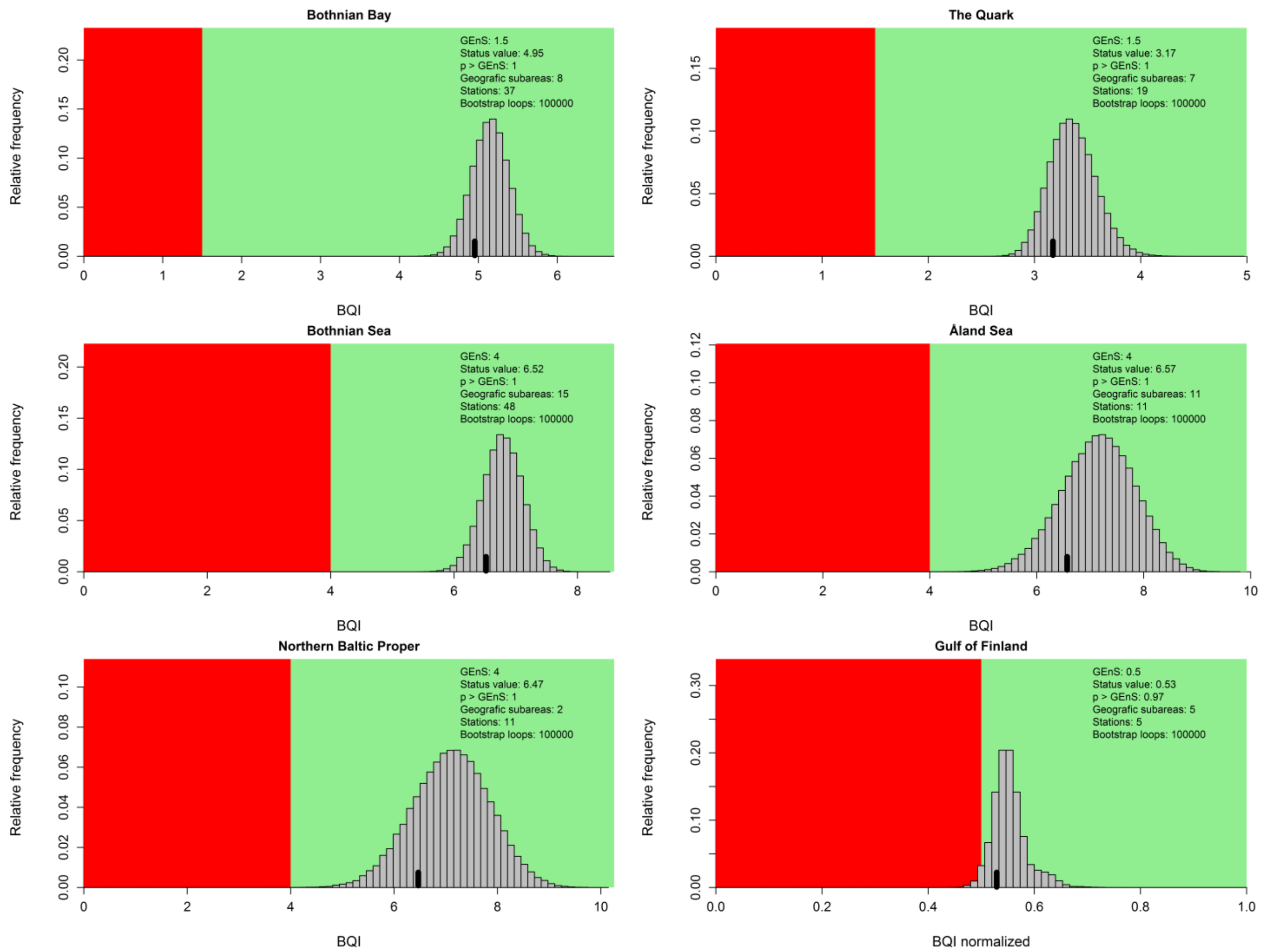
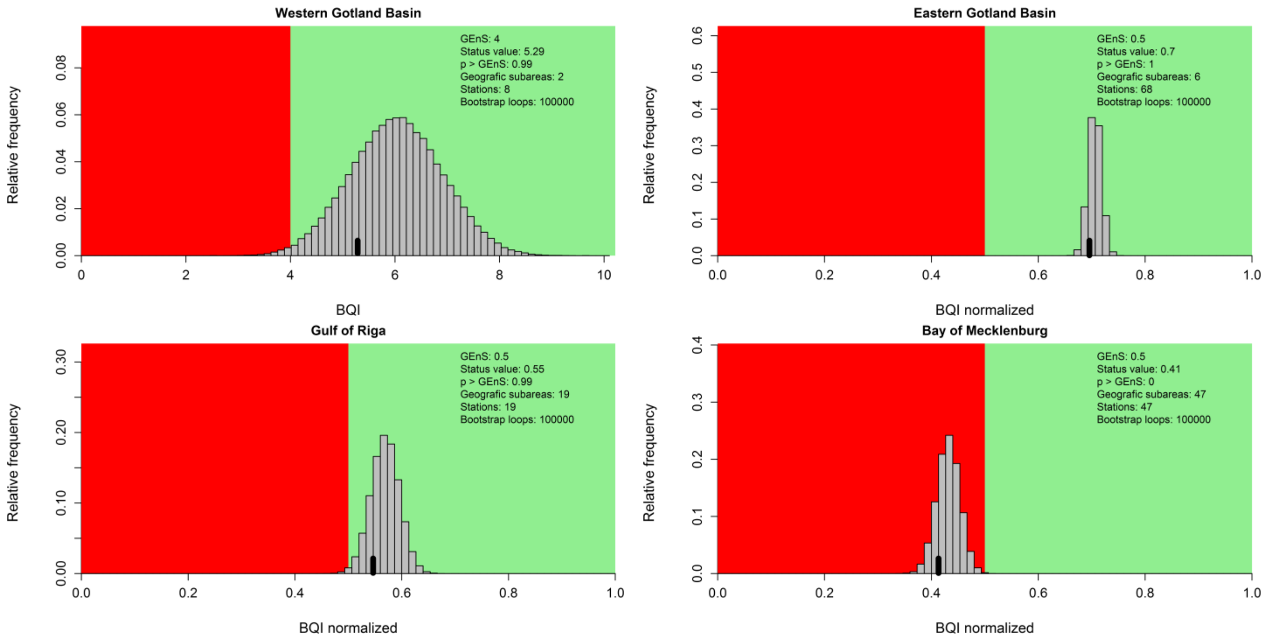
Results and Confidence

In the period 2011-2015, the result of the indicator show good status in all the evaluated open sea assessment units apart from the Bay of Mecklenburg (Results Results figure **1**).

It has to be noted that the indicator in the central Baltic Proper only represents the areas above the halocline (< 60m depth). In the Northern Baltic Proper, Gulf of Finland, Eastern Gotland Basin and Western Gotland Basin the areas below the halocline suffer from hypoxia. The hypoxia is partly controlled by natural factors and partly a result of anthropogenic eutrophication. A reliable threshold value that would indicate good status if an area is only affected by natural hypoxia could not be set for these sub-basins. It is recommended that the oxygen debt indicator (http://www.helcom.fi/baltic-sea-trends/indicators/oxygen-debt/) is used to evaluate the status below the halocline in these sub-basins.

Further, it should be noted that the indicator and its associated threshold values are still being tested in some countries and may be further developed in HELCOM as a result of the outcome of the testing, or the results may show that the indicator is not suitable for use in a specific sub-basin. The results should thus only be considered as intermediate. In particular it should be noted that the threshold value is considered intermediate in the Gulf of Finland, Gulf of Riga, and Eastern Gotland Basin.





Results figure 1. Evaluation results for the sub-basin open sea assessment units. The histograms reflect the distribution of the 100 000 bootstrapped mean BQI values and the black bar show the evaluation value (20th percentile) which is compared to the threshold value (see Assessment Protocol for details). The red and green areas correspond to failing and achieving the assessment unit specific threshold value respectively.[1]

Confidence of the indicator status evaluation

The confidence of the indicator result is generally **high**, however regional differences occur as there is variation in how well the data covers the assessed areas spatially and temporally.

The spatial representativity of data in the assessment units was considered to be high in Bothnian Bay, the Quark, Bothnian Sea, Åland Sea, Gulf of Riga and Bay of Mecklenburg. In the Gulf of Finland, Northern Baltic Proper and Western and Eastern Gotland Basins, the sampling stations are very scattered compared to the large assessment units and the spatial representativity is considered to be low (see Results figure 2). The temporal representativity of the data is considered to be intermediate. Even if data has been collected all years in the assessment period 2011-2015 in all assessment units, apart from the Åland Sea where data from year 2011 is missing, some stations are only sampled one year or a few years and the number of samples taken per station and year vary from 1 to 10. This temporal and methodological unbalance is handled with the bootstrap method used to calculate the actual indicator value used for evaluation of the status (see Assessment protocol for method description).

In all assessment units, the confidence of the classification was high. In the areas in good status the probability of being above the threshold was high (p>0.97) and in Bay of Mecklenburg which was assessed to be below the threshold, the probability for being above the threshold was 0.

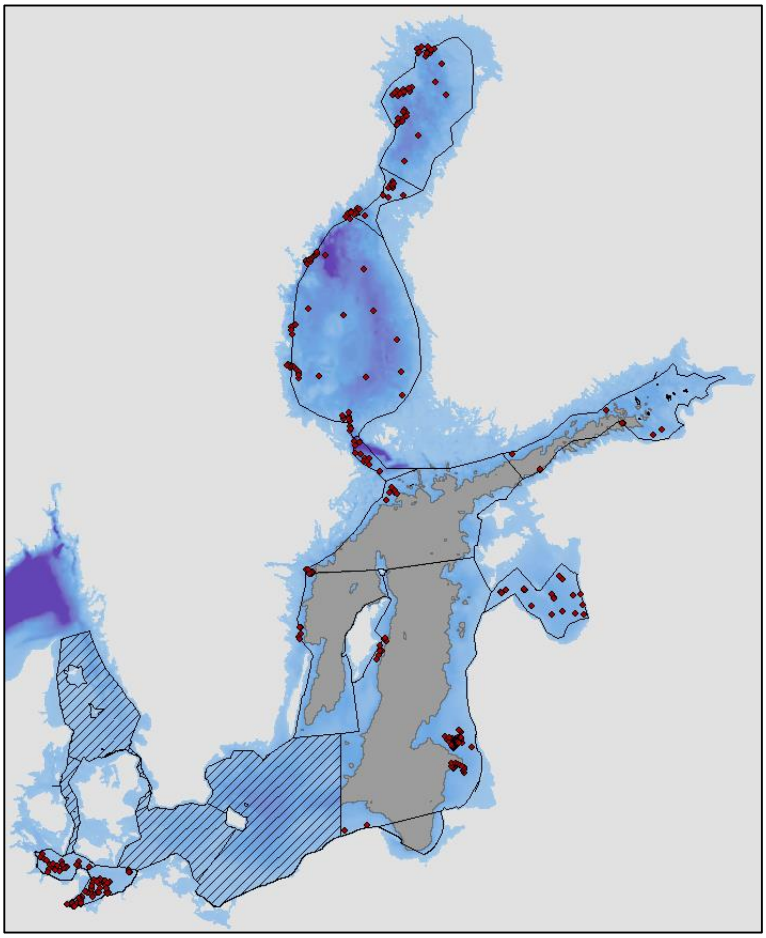
[1] Data for Kiel Bay foreseen by end of 2017

Result Table 1. Confidence assessment of the indicator evaluation in the assessment units. See text for further explanations.[2]

Assessment unit	Certainty of classification	Spatial representativity of data	Temporal representativity of data
Bothnian Bay	High	High	Intermediate
The Quark	High	High	Intermediate
Bothnian Sea	High	High	Intermediate
Åland Sea	High	High	Intermediate
Northern Baltic Proper	High	Low	Intermediate
Gulf of Finland	High	Low	Intermediate
Western Gotland Basin	High	Low	Intermediate
Eastern Gotland Basin	High	Low	Intermediate
Gulf of Riga	High	High	Intermediate
Bay of Mecklenburg	High	High	Intermediate

The confidence of the indicator results was assessed using spatial and temporal representativity of data and an estimate of the probability that the status is above the threshold derived from the distribution of the 100 000 bootstrapped BQI-values (see Assessment protocol for description). Methodological confidence was considered to be high as differences in sampling gear (e.g. sieve mesh sizes) are already corrected for in the subsets (see Assessment Protocol for description).

[2] Data for Kiel Bay foreseen by end of 2017

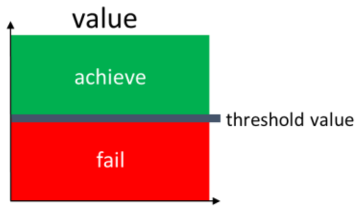


Result figure 2. Soft-bottom macrofauna stations used in assessment. The grey area represent below halocline depths and are only assessed with the indicator 'Oxygen debt'. Hatched areas represent areas where no thresholds have been agreed and hence no assessments were done.

Good Environmental Status

Note: Some of the threshold values applied in the indicator are still subject to verification and have been agreed to be used as intermediate values in this core indicator report. Based on further testing the threshold values may still be adjusted.

The thresholds values to evaluate good environmental status have been set using two different approaches based on which method for species sensitivity values that was used. The threshold value concept is a defined value that should be achieved in order to indicate good status (Good environment status Figure 1).



Good environmental status figure 1. The schematic figure of the threshold value concept applied in the core indicator.

In the northern assessment units where the method follows Leonardsson *et al*. (2009) the Swedish intercalibrated BQI good-moderate threshold values for outer coastal waters, developed for the purposes of assessments under the EU Water Framework Directive, are considered to also be applicable for the open sea assessment units. The establishment of these threshold values is based on both statistical tests and expert judgment using data from areas without local disturbance representing high and good status as baselines as described in Leonardsson *et al*. (2009).

In the southern assessment units the threshold is defined based on methods described in Schiele *et al*. (2016). In this method the fauna sub-sets that are described in the method and occur in the assessment unit are first identified. Threshold values are then calculated for each subset according to a pragmatic statistical scheme developed by Perus *et al*. (2007) and later modified during the intercalibration process as described by Carletti & Heiskanen (2009). In short, this method sets the threshold values to 0.6 times the 10^{th} percentile of the top 10 % of all index values within a subset. Threshold values for all open sea assessment units are shown in Good environmental status table 1.

Good environmental status table 1. Threshold values used in the assessed open sea assessment units.[3] In the northern units one threshold value per unit is given whereas in the southern units one threshold value per subset irrespective of assessment unit is given, thus one assessment unit may have more than one threshold value. Note that threshold values in assessment units where the Schiele *et al*. (2016) sensitivity value method is used will be 0.5 after normalisation to a common scale (see Assessment protocol for details).

Open sea assessment unit	**Assessed depths**	**Threshold value**									**BQI species sensitivity value method**
		Subset according to Schiele *et al*. 2016									
			2	**3**	**4**	**8**	**9**	**11**	**12**	**13**	
Bothnian Bay		1.5									Leonardsson *et al*. 2009
The Quark		1.5									Leonardsson *et al*. 2009
Bothnian Sea		4.0									Leonardsson *et al*. 2009
Åland Sea		4.0									Leonardsson *et al*. 2009
Northern Baltic Proper	<60 m	4.0									Leonardsson *et al*. 2009
Western Gotland Basin	<60 m	4.0									Leonardsson *et al*. 2009
Gulf of Finland	<60 m							0.93		1.07	Schiele *et al*. 2016
Gulf of Riga									1.59	1.07	Schiele *et al*. 2016
Eastern Gotland Basin	<60 m					1.81	2.11				Schiele *et al*. 2016
Bay of Mecklenburg			7.22	5.44	4.52						Schiele *et al*. 2016

No threshold value has been agreed for the following open sea assessment units; Kattegat, Great Belt, the Sound, Arkona Basin, Bornholm Basin and Gdansk Basin. The indicator is in principle applicable in these areas, and work on defining threshold values also for these assessment units has been planned and will continue during 2017.

[3] Data for Kiel Bay foreseen by end of 2017

Assessment Protocol

Evaluating the status of soft-bottom macrofauna in the open sea assessment units is done using a method based on a common indicator, the Benthic Quality Index (BQI), where the abundance weighted proportion of sensitive to tolerant taxa and the diversity of the community are the determining parameters. Generally, the higher the proportion of sensitive taxa and the higher the number of different species, the better the environmental status is evaluated to be.

Contracting Parties of HELCOM that are also EU Member States have developed methods for assessing the coastal areas using benthic invertebrates for the purpose of the EU Water Framework Directive (WFD). WFD Good Ecological Status (GEcS) threshold values as well as the specific index to be used, has been defined in national legislation. To avoid developing two contradictory environmental status evaluation outcomes in the coastal areas using benthic invertebrates, the pragmatic proposal is to integrate the national assessments from the WFD framework to the indicator in the coastal areas and to use a common HELCOM method for evaluating the open sea areas. In the deeper parts of some open sea areas in the Baltic Proper the environmental status will be evaluated with the indicator 'Oxygen debt'.

The BQI approach has been developed through several consecutive studies (Rosenberg *et al*. 2004, Leonardsson *et al*. 2009, Leonardsson *et al*. 2015, Leonardsson *et al*. 2016 and Blomqvist & Leonardsson 2016). In this core indicator the version of the index to be used is the formula as presented in Leonardsson *et al*. (2009):

$$BQI = \left[\sum_{i=1}^{S_{classified}} \left(\frac{N_i}{N_{classified}} * Sensitivity\ value_i\right)\right] * log_{10}(S+1) * N/(N+5)$$

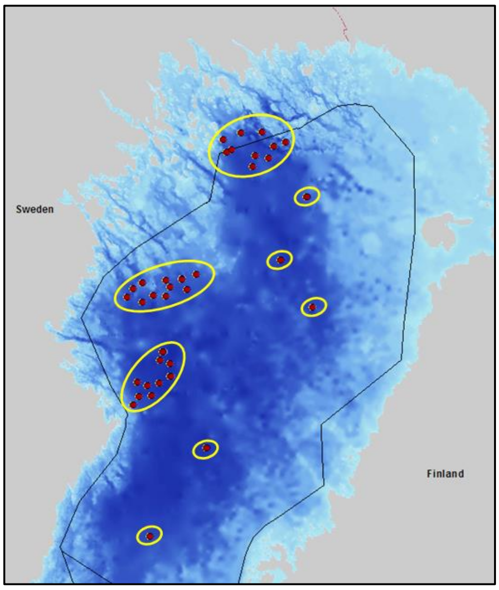
where $S_{classified}$ is the number of taxa having a sensitivity value, N_i is the number of individuals of taxon i, $N_{classified}$ is the total number of individuals of taxa having a sensitivity value, the Sensitivity $value_i$ is the sensitivity value for taxon i, S is the total number of taxa, and N is the total number of individuals in the sample (recalculated to 0.1 m^2).

Sensitivity values to be used originate from two different concepts and sources; a) literature information on sensitivity to disturbance and expert knowledge according to Leonardsson *et al*. (2009) are to be used in the Gulf of Bothnia, Åland Sea, Norther Baltic Proper and Western Gotland Basin and b) calculated values based on taxa occurrence at different diversities according to Schiele *et al*. (2016) are to be used in the Gulf of Finland, Gulf of Riga, Eastern Gotland Basin and Bay of Mecklenburg. The sensitivity values in Leonardsson *et al*. (2009) are constant in the whole Baltic and the same as used for WFD assessment in both Sweden and Finland. Sensitivity values calculated according to Schiele *et al*. (2016) are different for different salinity/depth/gear subsets. Salinities for the sampling stations were retrieved using the modelled EUSeaMap values (http://www.emodnet-seabedhabitats.eu/default.aspx?page=1953) in order to have a set salinity for the sampling stations and avoid that same stations are put in different subset based on the observed salinity at sampling. In total 19 different subsets are identified by Schiele *et al*. (2016) but only eight of these are present in the assessment units where this concept is used at present. In each of these assessment units there are more than one subset present. Since each subset will have a different range of sensitivity values separate calculations have to be performed for each subset and later merged to give a final assessment value for the assessment unit.

Assessment calculations

In the assessment units Gulf of Finland, Gulf of Riga, Eastern Gotland Basin and Bay of Mecklenburg more than one set of sensitivity values were used in the calculation of BQI, one set for each subset. To make the BQI values comparable across the subsets, normalization to a common scale between 0 and 1 was done, with the threshold value scaled to 0.5 and setting the maximum observed BQI value in the subset to 1. In the assessment units where only one set of sensitivity values were used (Bothnian Bay, The Quark, Bothnian Sea, Åland Sea, Northern Baltic Proper and Western Gotland Basin) no normalization was needed and the BQI values were used as such.

In order the account for spatial, temporal and sample replicate unbalance a bootstrap procedure was used to estimate the 20th percentile to be compared against the threshold value. The 20th percentile is used as a precautionary or "fail-safe" approach (Carstensen 2007, Leonardsson *et al*. 2009) letting high uncertainty result in lower status. Spatial unbalance with several stations concentrated to smaller parts of the assessment area is overcome by defining geographic subareas. The spatial unbalance often arise from different monitoring designs used in different countries, e.g. the cluster design in Sweden and a single station design in Finland (see example in Assessment protocol figure).



Assessment protocol figure 1. Example of geographic subareas used to overcome spatial unbalance in the bootstrap process. Red dots represent sampling stations and yellow circles geographic subareas in the assessment unit the Bothnian Bay.

The bootstrap process for one assessment unit and one assessment period follow these steps:

1) Randomly select one geographic subarea
2) Randomly select one station from this subarea
3) Randomly select one grab from this station irrespective of year and sample number and store its BQI-value
4) Repeat step 1 to 3 as many times as there are stations in the assessment unit
5) Calculate the mean of the stored BQI-values and store this mean BQI-value

6) Repeat steps above 100 000 times
7) Calculate the 20th percentile of the stored 100 000 mean BQI-values

The 20th percentile from step 7 is the indicator value to be compared with the threshold value of the assessment unit.

Assessment units

The indicator is calculated for HELCOM assessment unit scale 3 open sea assessment units. There are 17 open sea assessment units defined in the HELCOM Monitoring and Assessment Strategy Annex 4. The units are delineated based on the 1 nautical mile boundary from the coast.

Relevance of the Indicator

Biodiversity and eutrophication assessment

The status of biodiversity is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation, this indicator will also contribute to the integrated biodiversity and eutrophication assessment.

Policy relevance

The core indicator has mainly been developed with the aim to evaluate the HELCOM ecological objective 'Thriving communities of plants and animals' (Nature conservation). Some information of relevance can be gained also when assessing 'Natural distribution and occurrence of plants and animals' (Eutrophication).

Under the EU Marine Strategy Framework Directive, the indicator describes the state of benthic habitats linking both to the qualitative descriptors 1: Biodiversity and 6: Sea-floor integrity (Criterion D6C5), as well as descriptor 5:Eutrophication (Criterion D5C8).

Role of soft-bottom macrofauna in the ecosystem

Macrofauna species live in the sediment or at the interface between the water mass and the sediment. The macrozoobenthic community influences the marine nutrient turnover by coupling the cycles of both compartments, known as the benthic-pelagic coupling. Foraging and burrowing activities in the sediments influence the oxygenation of the sediments and influences the chemical processes in the sediments. In addition to forming a link between the water mass and the sediments, the macrozoobenthic species also form an important link in the marine food web. Many of the macrozoobenthic species are primary consumers that filter particles from the water or graze on and in the sediments while others are predators and scavengers. As well, many marine top-predators feed on these macrozoobenthic species. As the main part of the seafloor is covered by soft sediments, the macrozoobenthic community is clearly a key component to be considered in any assessment of the status of the environment.

The composition of the macrozoobenthic community varies across environmental gradients and reflects parameters such as salinity, oxygen, food supply, biotic interactions and hydrological conditions. Changes in the environmental parameters will result in changes of the community composition. In addition to changes due to natural environmental fluctuations, the composition is also affected by anthropogenic pressures.

Generally, Baltic soft-bottom macrofauna are characterized by small shallow-dwelling species owing to low salinity and transient hypoxia; historically it was only in the southern Baltic where more mature communities composed of deeper-dwelling, larger species, e.g. some long-lived bivalves and large polychaetes, could have developed. In the open sea areas of the northern sub-basins, the soft-bottom macrofauna community is dominated by a small number of species, including for example, the amphipods *Monoporeia affinis* and *Pontoporeia femorata*, the isopod *Saduria entomon*, the polychaets *Bylgides sarsi* and *Marenzelleria* spp. and the bivalve *Macoma balthica.* In the open sea areas of the southern sub-basins the communities are markedly different with dominance of clearly marine species, including for example, the bivalves *Arctica islandica* and *Astarte borealis* and numerous species of polychaetes.

The latitudinal distribution of marine macrofauna in the Baltic Sea is limited by the gradient of decreasing salinity towards the north. The decreasing salinity reduces soft-bottom macrofauna diversity, affecting both the structure and function of soft-bottom macrofauna communities (Elmgren 1989, Rumohr *et al*. 1996, Bonsdoff & Pearson 1999, Villnäs & Norkko 2011, Gogina *et al*. 2016).

The distribution of soft-bottom macrofauna communities is also driven by strong vertical gradients. Generally, more species-rich and abundant communities are found in shallow-water habitats (with higher habitat diversity) compared to 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 and seasonal pycnoclines in coastal waters restrict vertical water exchange, which may result in oxygen deficiency is without question the most significant threat to the biodiversity of the Baltic Sea soft-sediment macrofauna community. In the open sea, the communities have for several decades been severely affected by oxygen depletion. Current evidence suggests that the spatial and temporal extent of oxygen deficiency has increased over the past decades. In this indicator, only the area above the halocline, not suffering from permanent hypoxia, is assessed.

The soft-bottom macrofauna species that make up the community have different characteristics and react differently to anthropogenic pressures, making an evaluation of the composition and abundance of species in the community in a specific area a good indicator for evaluating the status of the environment. In the marine area where one sample from the monitoring effort needs to represent a larger area as well as a relevant time period, the macrozoobenthic community is considered a good indicator due to the fact that the relatively stationary and long-lived species (years to decades) integrate environmental information and reduces fluctuations in the dataset once natural variability has been taken appropriately into account.

The assessment results show good status for most basins, even in eutrophied or otherwise impacted areas. As the indicator concept is based on sensitive species and diversity, the impacts of the main pressures affecting the benthic fauna are expected to be reflected in the assessment results. Further development of the indicator and its assessment thresholds may be needed to achieve better alignment between the assessment of pressures and their impacts on benthic habitats and benthic fauna.

Human pressures linked to the indicator

	General	MSFD Annex III, Table 2a
Strong link	eutrophication, seabed disturbance e.g. trawling, contamination e.g. oil spill	Physical - Physical disturbance to seabed (temporary of reversible) Substances, litter and energy - Inputs of nutrients – diffuse sources, point sources, atmospheric deposition - Inputs of organic matter – diffuse sources and point sources - Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) – diffuse sources, point sources, atmospheric deposition, acute events Biological - Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities)
Weak link		

Soft-bottom macrofauna community composition is a very good indicator of environmental status because the result integrates several pressures on the environment over a moderate period of time. This quality of the soft-bottom macrofauna community implies that status changes can, however only be indirectly linked to anthropogenic pressures. The soft-bottom macrofauna community structure is affected by eutrophication (including oxygen deficiency), changes in water and sediment quality and hydrographic conditions such as salinity or temperature as well as physical damage to the seafloor.

Indicator relevance Table 2. The effect of anthropogenic pressures on macrozoobenthic diversity.

Status of diversity	Anthropogenic pressure
Improved	Slight eutrophication
Reduced	Severe eutrophication (incl. oxygen deficiency)
Reduced	Physical disturbance (due to abrasion, smothering, changes in siltation)
Reduced	Physical loss (due to sealing or selective extraction)
Reduced	Introduction of synthetic compounds (due to ship accidents or harbours)
Altered	Changes in the hydrological conditions (due to changes in salinity and/or temperature)

The anthropogenic pressure the indicator clearly reacts to in large areas of the Baltic Sea is eutrophication that causes hypoxia and anoxia in bottom waters (Pearson and Rosenberg 1978, Hyland *et al*. 2005, Norkko *et al*. 2006). Hypoxia has resulted in habitat destruction and the elimination of benthic macrofauna over vast areas and has severely disrupted benthic food webs. In food-limited soft-bottom macrofauna communities, an increase in organic material input and subsequent disturbance are initially seen as large fluctuations in benthic diversity, abundance and biomass. Species composition changes as conditions deteriorate, and the advantage gained by smaller-sized, tolerant species results in decreasing total biomass and diversity of the soft-bottom macrofauna community as sensitive, large-sized and long-lived species disappear. At advanced stages of organic enrichment, most bottom-water oxygen is consumed by the aerobic microbial decomposition of organic material, resulting in hypoxia and anoxia and initiating the release of toxic hydrogen sulphide from the sediments. At these advanced stages of hypoxia and anoxia, soft-bottom macrofauna is eliminated and important ecosystem services are lost.

The most severe damage from the physical pressure of trawling is apparent in the southern areas of the Baltic Sea where the soft-bottom macrofauna community is dominated by very long-lived species of clams and mussels. In other coastal areas the main physical damage of relevance to the soft-bottom macrofauna community stems from dredging activities and dumping of dredged materials. Dredging and dumping activities can change local hydrographical conditions as well as change siltation rates especially in the short term.

Monitoring Requirements

Monitoring methodology

Monitoring of soft-bottom macrofauna is described in general terms in the HELCOM Monitoring Manual in the Programme Topic Benthic community species distribution and abundance. Monitoring specifically on soft-bottom macrofauna communities is further described in the sub-programme: Softbottom fauna. The Monitoring Concepts Table summarizes ongoing monitoring activities.

Monitoring guidelines describing the sampling strategy are to be included in the HELCOM Monitoring Manual. The guidelines are currently under development and will be included at a later stage.

Current monitoring

The monitoring activities relevant to the indicator that are currently carried out by HELCOM Contracting Parties are described in the HELCOM Monitoring Manual

Sub-programme:
The Monitoring Concepts Table lists the Contracting Parties currently monitoring soft-bottom macrofauna.

Description of optimal monitoring

For an optimal assessment of the status of soft-bottom communities, the benthic macrofauna should be monitored in all coastal and open sea assessment units. Monitoring design should optimally take into account the habitat heterogeneity within the assessment unit to cover the spatial variation in communities. Ideally, the same methodology should be applied throughout the Baltic Sea.

Data and updating

Access and use

The data and resulting data products (tables, figures and maps) available on the indicator web page can be used freely given that the source is cited. The indicator should be cited as following:

HELCOM (2017) State of soft-bottom macrofauna community. HELCOM core indicator report. Online. [Date Viewed], [Web link].

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Metadata

Result: State of the soft-bottom macrofauna community

The snapshot dataset on macrofauna includes data from DK, EE, FI, DE, LV, LT, PL, SE

Data was extracted from the HELCOM COMBINE database, hosted at ICES. The extracted dataset was supplemented with additional data from Estonia, Latvia, Lithuania and Germany.

Offshore waters: Monitoring started in some places in 1964. Current status is representing the time period 2011-2015. Monitoring is on-going and contracting parties are reporting data yearly to the COMBINE database at ICES.

Contributors and references

Contributors

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HELCOM Intersessional Network on Benthic habitat monitoring (IN-BENTHIC)

Archive

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