Communities of Baltic lower circalittoral soft sediments (mud and sand)

Summary

This is a Baltic Sea benthic habitat in the aphotic zone, comprising areas of soft sediment, predominantly mud, below the halocline, typically at depths below 70-100m. The strong permanent halocline and seasonal thermocline in summer limits vertical mixing of the water column leading to the formation of oxygen-depleted zones in the deep areas of the central Baltic.

The environmental conditions of the deep zone of the Baltic are not uniform but vary widely in terms of salinity (14-21 ppt) and oxygenation (3-80% saturation). During periods of stagnation, this separation by the halocline gives rise to an oxygen deficit and periodically to complete oxygen depletion and formation of hydrogen sulphide (H_2S). In places there is a continuously oxygen poor zone which is virtually devoid of macrofauna and has an extremely impoverished meiofauna generally consisting of a few thousand nematodes per square meter only.

Although this habitat is naturally periodically affected by oxygen depletion, eutrophication is believed to be responsible for increasing the affected area and the duration of these episodes. Bottom trawling which, even on a single year of data, has been reported to potentially impact more than 30% of the area of this habitat, can also affect benthic communities directly and influence the recovery time. Climate change effects, such as modification of hydrographic conditions is likely to be another pressure. Measures to reduce eutrophication can reduce the impact and longevity of naturally occuring anoxic periods which affect this habitat and limiting bottom trawling can contribute to allowing recovery of this habitat .

Synthesis

There has been a marked decline in the quality of this habitat, which is apparent from the drastic changes in species and functional guild composition in central and northern sub-halocline areas including the gradual disappearace of *Scoloplos armiger* between the 1950s and 1990s. Former mollusc dominated communities that were still present in the southern Baltic in the early 1950s have been replaced by communities dominated by polychaetes. In the Gulf of Finland, mass occurrence of several macrobenthic animals at depths of 80-90 m and even deeper was not a rare phenomena. This has not been the case since 1989/90 despite some recolonisation. Demersal fisheries are widespread and also believed to have affected the quality of this habitat.

Habitat extent has also been affected. The earliest records of severe bottom water hypoxia and anoxia are from around 1950. Bottom water and sedimentary areas with low oxygen concentrations have been spreading during the latter part of the 20th century and the presence of H_2S has become a permanent feature of the Gansk, Bornholm and Gotland Deeps. Naturally, hypoxia occurs intermittently, but the areas affected have expanded from <10,000 km^2 before 1950 to >60,000 km^2 since 2000. This is believed to be mainly caused by enhanced nutrient inputs.

On the basis of expert opinion, this habitat is assessed as Vulnerable for both the EU 28 and EU 28+ since there has been a substantial reduction in quality affecting more than 30% of its extent over the last 50 years. This is a consequence of expansion of the area permanently or temporarily affected by anoxia.

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Vulnerable	C/D1	Vulnerable	C/D1

Sub-habitat types that may require further examination

None.

Habitat Type

Code and name

Communities of Baltic lower circalittoral soft sediments (mud and sand)

Seabed in the Gotland Deep (© OCEANA).

Habitat description

This is a Baltic Sea benthic habitat in the aphotic zone, comprising areas of soft sediment, predominantly mud, below the halocline . The upper water layer is separated from the more saline deepwater layer by a permanent halocline located at depths of about 70-100 m (there is no halocline in the shallower areas in the northeastern Baltic). The strong permanent halocline and seasonal thermocline in summer limits vertical mixing of the water column leading to the formation of oxygen-depeted zones in the deep areas of the central Baltic. The pycnocline in the Baltic occurs around 80m of depth and below this hypoxia and anoxia occur almost permanently. Salinity has risen since early records at the beginning of the 20th century and increasing stability of the halocline restricts water exchange between the more saline bottom layer and overlying water masses. The environmental conditions of the deep zone of the Baltic are not uniform but vary widely in terms of salinity (14-21 ppt) and oxygenation (3-80% saturation). The conditions depend in the first instance on influxes, which are very irregular, which renew the deep waters with oxygen. Between 1948-52, for example, when there was frequent renewal of deep waters, worms such as *Halicryptus spinulosus* and *Scoloplos armiger* were present whereas during 1956-57 lack of influxes led to the extinction of the fauna in the deeper parts of the Bornholm and Gdansk Deeps. The three deep basins in the central Baltic are the Bornholm Basin, Gdansk Deep and Gotland Basin. In the Bornholm Basin, the Central Basin and the Gulf of Finland, the bottom layer is separated from the surface layer by a permanent halocline. During periods of stagnation this separation gives rise to an oxygen deficit and periodically to complete oxygen depletion and formation of hydrogen sulphide. The result is a total disappearance of macrofauna in the deepest part of these basins. In places there is a constant oxygen poor zone which is virtually devoid of macrofauna and has an extremely improvershed meiofauna, which generally consists of only a few thousand nematodes per square meter. Comparison of the persistence of the soft bottom macrofauna in the deeper parts of the Baltic between areas that the communities of the Gulf of Bothnia are the most stable, while those of the Bornholm and Gdansk Deeps vary strongly, mainly owing to the periodic oxygen deficit. Physical forcing can remedy deoxygenation effects of eutrophication through enhanced vertical mixing. The Slupsk furrow differs from other deep water areas of the Baltic Proper in both the salinity and oxygen content. All the remaining deep areas (the Bornholm, Gdansk and Gotland Deeps) are plagued by periodic oxygen depletion and/or the presence of H_2S in the near-bottom water. At present the Slupsk furrow is the only part of the Baltic Proper where bottom areas below the isohaline water layer are inhabited by a number of marine species which take advantage of the relatively high salinity and acceptable oxygen content.

Indicators of quality:

Both biotic and abiotic indicators have been used to describe marine habitat quality. These include: the presence of characteristic species as well as those which are sensitive to the pressures the habitat may face; water quality parameters; levels of exposure to particular pressure, and more integrated indices which describe habitat structure and function, such as trophic index, or successional stages of development in habitats that have a natural cycle of change over time. There are no commonly agreed indicators of quality for this habitat, although particular parameters may have been set in certain situations e.g. protected features within Natura 2000 sites, where reference values have been determined and applied on a location-specific basis.

Characteristic species:

Where there is sufficient oxygen and elevated salinity – Copepods (Harpacticoida) e.g. L*aophonte baltica, Amphiascoides dispar* and *Kliopsyllus constrictus*. In the deeps around Gotland the polychaetes *Scoloplos arminger* and where the substrate is predominantly clay *Pontoporeia femorata* and *Terebellides stroemi.*

Classification

EUNIS:

The closest correspondence in EUNIS (2004) level 4 is A5.21 Sublittoral sand in low or reduced salinity, A5.41 Sublittoral mud in low or reduced salinity, A5.37 Deep circalittoral sand and A5.37 Deep circalittoral mud.

Annex 1:

The relationship between HUB biotopes and Annex 1 habitats has not yet been mapped by HELCOM, however this habitat may occur in the following Annex 1 habitats:

1650 Boreal Baltic narrow inlets

MAES:

Marine - Marine inlets and transitional waters

Marine - Coastal

Marine - shelf

MSFD:

Shelf sublittoral sand

Shelf sublittoral mud

EUSeaMap:

Shelf sands

Shelf muds

IUCN:

9.4 Subtidal sandy

9.5 Subtidal sandy-mud

9.6 Subtidal muddy

Does the habitat type present an outstanding example of typical characteristics of one or more biogeographic regions?

Yes

Regions
Baltic

Justification
Large parts of seabed in the deeper regions of the Baltic lie below the halocline, although the extent can vary from year to year depending on the influx of oxygenated saline water through the Kattegat. Factors which influence the frequency and persistence of such inflows include weather conditions and circulation patterns, and are therefore unpredictable.

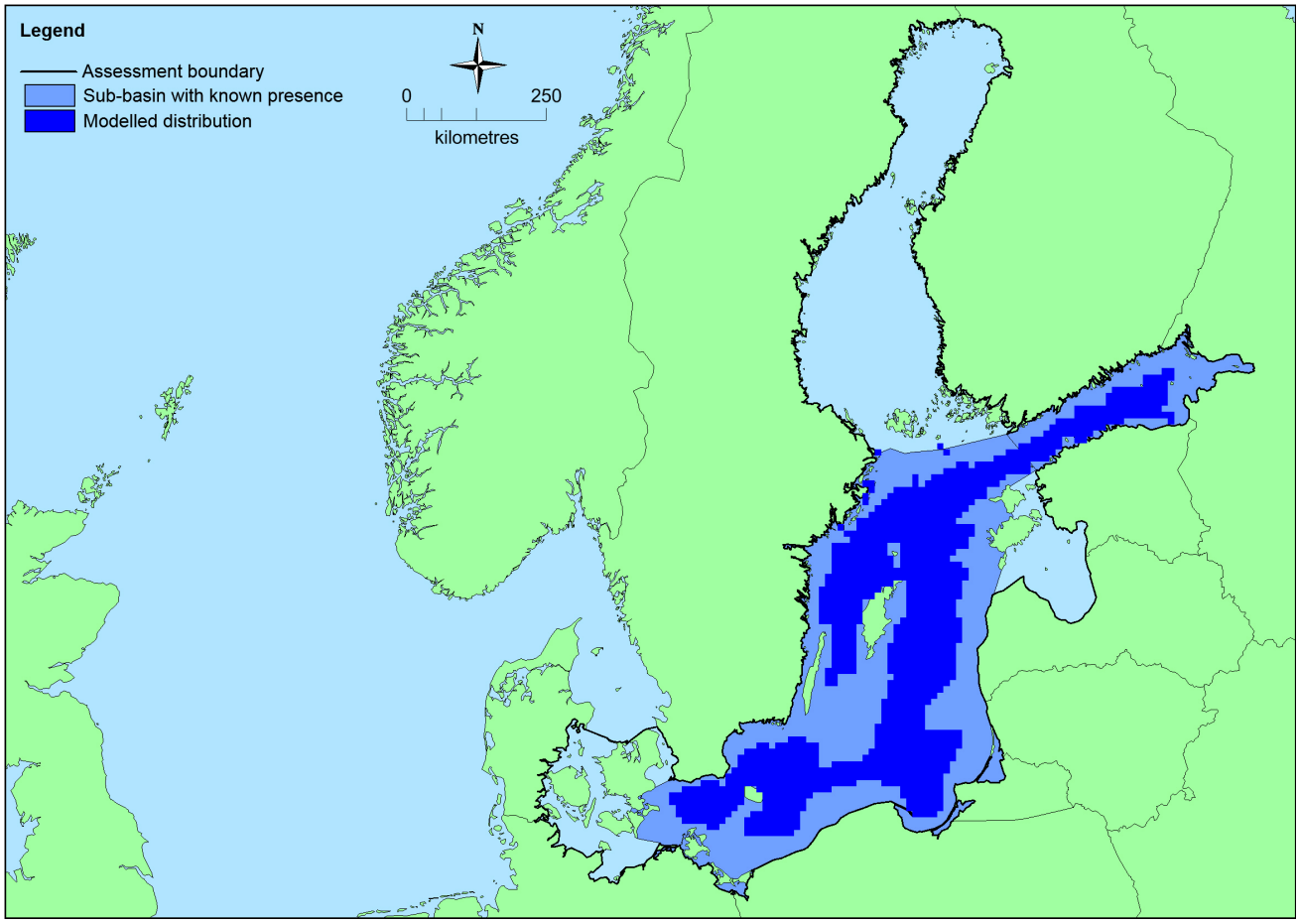
Geographic occurrence and trends

Region	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
Baltic Sea	Baltic Proper: Present Gulf of Finland: Present	60,927 Km^2	Decreasing	Decreasing

Extent of Occurrence, Area of Occupancy and habitat area

	Extent of Occurrence (EOO)	Area of Occupancy (AOO)	Current estimated Total Area	Comment
EU 28	>50,000 Km^2	Unknown	60,927 Km^2	Based on EUSeaMap modelling. Mapped extent of this habitat is recognised as biased and underestimated.
EU 28+	>50,000 Km^2	Unknown	60,927 Km^2	Based on EUSeaMap modelling. Mapped extent of this habitat is recognised as biased and underestimated.

Distribution map



There are insufficient data to provide a comprehensive and accurate map of the distribution of this habitat. This map has therefore been generated using the modelled data available on EMODnet for EUNIS level 3 habitats in the Baltic Sea (EMODnet, 2010). This means it indicates potential areas in which this habitat may occur, not the actual distribution of this EUNIS level 4 habitat. EOO and AOO cannot be calculated at the present time.

How much of the current distribution of the habitat type lies within the EU 28?

This habitat type does not occur in the Russian Baltic Sea area therefore 100% is hosted by EU 28 in the Baltic. This habitat may be present in other European regional seas.

Trends in quantity

This habitat is naturally subjected to intermittent periods of hypoxia. The frequency of such events is unpredictable but there has been a significant expansion of the area of seabed affected during such periods from less than10,000 km^2 before 1950 to over 60,000km^2 since 2000. This is believed to be mainly caused by enhanced nutrient inputs to the Baltic. In the Landsort Deep, oxygen conditions have deteriorated fairly steadily since the beginning of the last century and reached zero values around 1968. Since then there have been intermittent periods with better conditions at intermediate depths but no major improvements. In the central basin the area permanently devoid of macrofauna has grown since the early 20th century.

- Average current trend in quantity (extent)
  EU 28: Decreasing
  EU 28+: Decreasing
- Does the habitat type have a small natural range following regression?
  No
  Justification

The EOO is believed to exceed 50,000 50,000 km^2 therefore this habitat does not have a small natural range.

- Does the habitat have a small natural range by reason of its intrinsically restricted area?
  No
  Justification
  The EOO is believed to exceed 50,000 km^2 therefore this habitat does not have a small natural range.

Trends in quality

This habitat is naturally subjected to intermittent periods of anoxia. The frequency is unpredictable, but with longer periods and larger areas affected in recent decades, the scope for recovery by species such as *Articia islandica* are reduced. No successful spawning of *A.islandicia* has occurred in the muddy areas of Mecklenburg and Kiel Bight during the last decades and its disappearance or scarcity is in indicator of reduced quality of this habitat in parts of the Lubeck Bight and Kiel Bight. There has also been a severe decrease in the abundance of *Macoma balthica* in the Mecklenburg Bight and the Bornholm Basin. Former mollusc dominated communities that were still present in the southern Baltic in the early 1950s have been replaced by communities dominated by polychaetes. This may also be linked to the effects of demersal fishing gears. An analysis of the fishing intensity of EU trawlers (bottom otter, beam and mid-water trawls) using Automatic Identification System (AIS) ship tracking data over one year (September 2014 -2015) shows high coverage in all European coastal waters and over the continental shelf. When combined with the modelled distribution of EUNIS marine habitat types it is possible to examine the extent of likely impact on a particular benthic habitat. For example, over this time period around 30% of deep circalittoral mud habitats and around 40% of deep circalittoral sand habitats in the Baltic Sea (including the Kattegat) were subject to such fishing pressure.Given that this is based on a single year of data and that this type of pressure has been taking place for decades it is likely to be an underestimate of the total effect on this habitat.

In the Gulf of Finland, mass occurrence of several macrobenthic animals at depths of 80-90m and even deeper was not a rare phenomena. This has not been the case since 1989/90 despite some recolonisation.

- Average current trend in quality
  EU 28: Decreasing
  EU 28+: Decreasing

Pressures and threats

This habitat is naturally periodically affected by oxygen depletion but eutrophication is believed to be responsible for increasing the affected area and the duration of these episodes. Bottom trawling can also affect benthic communities directly and influence the recovery time. Climate change effects, such as modification of hydrographic conditions is likely to be another pressure. One plausible/possible consequence of global warming in the Baltic Sea is lowering of oxygen levels in the waters below the haloclines. Tolerance towards low oxygen differs between species, and the invasive bristle worms (*Marenzelleria* spp.) are more tolerant than for instance the native crustacean amphipods *Monoporeia* spp. and *Pontoporeia* spp. Increased hypoxic conditions in the Baltic Sea will likely promote dominance of the bristle worm *Marenzelleria* in the future, a shift that has already occurred in the Gulf of Finland.

List of pressures and threats

Biological resource use other than agriculture & forestry

Fishing and harvesting aquatic resources
Professional active fishing
Benthic or demersal trawling

Pollution

Nutrient enrichment (N, P, organic matter)

Invasive, other problematic species and genes

Invasive non-native species

Climate change

Changes in abiotic conditions
Temperature changes (e.g. rise of temperature & extremes)
Water flow changes (limnic, tidal and oceanic)

Conservation and management

Measures to reduce eutrophication can reduce the impact and duration of naturally occurring anoxic periods which affect this habitat. Limiting bottom trawling may be beneficial by allowing recovery of the habitat. The longer term effects of climate change are unknown, but changes in hydrographic conditions (e.g. water flow into the Baltic, salinity and temperature gradients) could potentially exacerbate the impact of anoxic periods on this habitat.

List of conservation and management needs

Measures related to wetland, freshwater and coastal habitats

Restoring/Improving water quality

Measures related to hunting, taking and fishing and species management

Regulation/Management of fishery in marine and brackish systems

Conservation status

This habitat does not correspond to any Habitats Directive Annex 1 habitat type.

When severely damaged, does the habitat retain the capacity to recover its typical character and functionality?

Unknown. Recovery will be influenced by the frequency and longevity of anoxic periods. As these occur naturally, are intermittent and unpredictable it is not possible to estimate time scales for recovery. It should however be noted that some of the associated species are long lived and have not recolonised areas affected in the 1950s. Recovery may also be hindered or slowed down by the colonisation of opportunistic species such as polychaetes and depending on larvael supply from healthier areas with established populations.

Effort required

Red List Assessment

Criterion A: Reduction in quantity

Criterion A	A1	A2a	A2b	A3
EU 28	25-30 %	Unknown %	Unknown %	Unknown %
EU 28+	25-30 %	Unknown %	Unknown %	Unknown %

The increase in extent of both permanent and temporary anoxic conditions in the lower circalittoral indicates a decline in quantity of this habitat. This species is assessed as Near Threatened under criterion

A since there is an estimated 25-30% decline in the quantity of this habitat over the last 50 years. There is no information on historic declines or future trends.

Criterion B: Restricted geographic distribution

Criterion B	B1				B2				B3
	EOO	a	b	c	AOO	a	b	c	
EU 28	>50,000 Km^2	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
EU 28+	>50,000 Km^2	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Modelled data suggest that the EOO of this habitat may exceed 50,000 km^2 however a lack of quantitative data means that this remains an estimate. AOO cannot be calculated at the present time. This habitat has therefore been assessed as Data Deficient under criterion B.

Criterion C and D: Reduction in abiotic and/or biotic quality

Criteria C/D	C/D1		C/D2		C/D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	30 %	Severe %	Unknown %	Unknown %	Unknown %	Unknown %
EU 28+	30 %	severe %	Unknown %	Unknown %	Unknown %	Unknown %

Criterion C	C1		C2		C3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	Unknown %	Unknown %	Unknown %	Unknown %	Unknown %	Unknown %
EU 28+	Unknown %	Unknown %	Unknown %	Unknown %	Unknown %	Unknown %

Criterion D	D1		D2		D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	Unknown %	Unknown%	Unknown %	Unknown%	Unknown %	Unknown%
EU 28+	Unknown %	Unknown%	Unknown %	Unknown%	Unknown %	Unknown%

It is estimated that there has been a severe decline in the quality of this habitat affecting more than 30% of its extent over the last 50 years as a result of the expansion of the area permanently or temporarily affected by anoxia. The extent of demersal fisheries and their ability to change the structure of benthic communities in areas of soft sediment, such as the decline in erect epifauna, is another sign of declining quality. This habitat is therefore assessed as Vulnerable under Criterion C/D and Criterion C/D1. There is no information about historic or future reductions is quality.

Criterion E: Quantitative analysis to evaluate risk of habitat collapse

Criterion E	Probability of collapse
EU 28	Unknown
EU 28+	Unknown

There is no quantitative analysis available to estimate the probability of collapse of this habitat type.

Overall assessment "Balance sheet" for EU 28 and EU 28+

	A1	A2a	A2b	A3	B1	B2	B3	C/D1	C/D2	C/D3	C1	C2	C3	D1	D2	D3	E
EU28	NT	DD	DD	DD	DD	DD	DD	VU	DD	DD	DD	DD	DD	DD	DD	DD	DD
EU28+	NT	DD	DD	DD	DD	DD	DD	VU	DD	DD	DD	DD	DD	DD	DD	DD	DD

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Vulnerable	C/D1	Vulnerable	C/D1

Confidence in the assessment
Low (mainly based on uncertain or indirect information, inferred and suspected data values, and/or limited expert knowledge)

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References

Andersin, A-B, Lassig, J. and Sandler, H. 1977. Community structures of soft bottom macrofauna in different parts of the Baltic.pg7- 20. In Keegan, B.F., Boaden, P.J.S & Ceidigh P.O. (Eds). Biology of Benthic Organisms: 11th European symposium on Marine Biology.

Axe, P. 2007. Hydrography and oxygen in the deep basins HELCOM Baltic Sea Environment Fact Sheets. Online. [Viewed 05/06/15], http://www.helcom.fi/baltic-sea-trends/environment-fact-sheets/.

Bergstrom, L., Diekmann, R., Flinkman, J. *et al.* 2010. Integrated ecosystem assessments of seven Baltic sea areas covering the last three decades. I*CES cooperative research report.* No.302

Drzycimski, I. 2000. The Slupsk Furrow as an Marine Protected Area in the Baltic. *Oceanological Sutdies* XXIX(2) 33-42.

Eigaard Ole R. *et al*. “Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions” ICES J. Mar. Sci., doi = 10.1093/icesjms/fsv099.

HELCOM. 2013. Red List of Baltic Sea underwater biotopes, habitats and biotope complexes. *Baltic Sea Environment Proceedings* 138, Helsinki Commission.

Karlson, K., Rosenberg, R. and Bonsdorff, E. 2002. Temporal and spatial large scale effects of eutrophication and oxygen deficiency on benthic fauna in Scandinavian and Baltic waters – A review. *Oceano.Mar Biol. Ann.Rev* 40:427-489

Naslund, J. 2011 Biotope classification of Swedish zoobenthos data for the Baltc EUNIS. *AquaBiota Water Research. Aquabiota Notes* 20011: 4. 16pp.

Tempera, F. 2015 Bringing together harmonised EUNIS seabed habitat geospatial information for the European Seas. *European Commission JRC Technical Report.*

Vespe M, Gibin M, Alessandrini A, Natale F, Mazzarella F, & Osio G. *in press*. Mapping EU fishing activities using ship tracking data – accepted for publication, *Journal of Maps* – available at *http://arxiv.org/pdf/1603.03826.*

Źmudsiński, L. 1966. *The conditons of distribution of bottom fauna in the Baltic Sea and its Adjacent Firths*. ICES. C.M. 1966/D:7 Baltic-Belt Seas Committee