HELCOM Red List II of the Baltic Sea

underwater biotopes, habitats and biotope complexes at risk of collapse

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Introduction

The Baltic Sea's habitats and biotopes

The Baltic Sea is an enclosed, non-tidal body of water with diverse ecosystems across its various basins. The brackish water, with salinity levels ranging from high marine conditions in the south to low freshwater conditions in the north, supports distinct habitats in the sea's different sub-basins. The coastline of the Baltic Sea also varies significantly. The southern shores are marked by long sandy beaches, while the northern regions are dominated by rocky and moraine shorelines. These coastal characteristics extend beneath the water's surface.

During the winter, the Baltic Sea is often covered by ice. Despite being relatively shallow, with an average depth of 52 meters (HELCOM 2009a), the water at the sea floor remains cold even in summer. Generally, the water in the Baltic Sea is more turbid than in oceanic waters, which means the photic zone—where photosynthetic plants, algae, and bacteria can thrive—is narrower compared to the oceans. In many areas, light doesn't reach the sea floor. However, due to the sea's shallow average depth, the photic zone extends over a large portion of the sea, particularly in the archipelagos (Figure 1).

The Baltic Sea's benthic biotopes vary in size and structure, from large, homogenous areas to small-scale mosaics, defined by seafloor substrate, bathymetry, as well as other environmental factors. They exhibit diverse functions and structures, where some are complex volumetric habitats created in the photic zone by perennial vegetation like *Fucus vesiculosus* on rocky bottoms or *Zostera marina* on sandy bottoms. And some in the aphotic zone, where biotopes are often dominated by semi-sessile macrofauna, such as blue mussels (*Mytilus spp.)* attaching to hard surfaces or ocean quahog (*Arctica islandica)* burrowing into soft substrates.

The HELCOM Red List II project

Regularly evaluating the status of biotopes, habitats and biotope complexes at risk of collapse in the Baltic Sea allows for tracking long-term trends in biodiversity and identifying changes in the condition of species and habitats. This process helps assess whether efforts to prevent biodiversity loss have been effective.

The goal of the HELCOM Red List II project was to assess the status of red-listed species and habitats/biotopes in the Baltic Sea, building on the results and insights from the previous HELCOM Red List project completed in 2013.

This HELCOM Red List II of Baltic Sea underwater biotopes, habitats and biotope complexes; and the HELCOM Red List II of Baltic Sea species in danger of becoming extinct complement and support each other and ought to be simultaneously considered by managers and policymakers. These updated assessment of the HELCOM Red List II for species and habitats/biotopes serves as a foundation for future regional work in HELCOM focused on biodiversity protection. It also provides a reference for Contracting Parties not currently conducting Red List assessments, as it illustrates the trends of the assessed species and habitats/biotopes across their distribution in the Baltic Sea. The Red List II assessment includes new data from areas where fresh information has been gathered and reflects a deeper understanding of the assessment process and related parameters.

The Red List II assessment plays a crucial role in monitoring the progress and effectiveness of HELCOM commitments, and it helps enhance the effectiveness and efficiency of measures by focusing on priority areas or species. The Red List II is closely connected to a wide range of commitments, both within HELCOM and externally, providing valuable information for evaluating the implementation of the HELCOM Baltic Sea Action Plan (see Table 1 below), as well as HELCOM Recommendations 37-2 and 40-1, along with several other Recommendations and Action Plans aimed at species of direct relevance:

— Recommendation 17/2 Protection of Harbour Porpoise in the Baltic Sea Area
— Recommendation 27-28/2 Conservation of seals in the Baltic Sea Area
— Recommendation 19/2 Protection and Improvement of the Wild Salmon (*Salmo salar L.*) populations in the Baltic Sea Area
— Recommendation 32-33/1 Conservation of Baltic Salmon (*Salmo salar*) and Sea Trout (*Salmo trutta*) populations by the restoration of their river habitats and management of river fisheries
— Recommendation 34E-1 Safeguarding important bird habitats and migration routes in the Baltic Sea from negative effects of wind and wave energy production at sea
— HELCOM Action Plan for the Protection and Recovery of the Baltic Sturgeon (*Acipenser oxyrinchus*) for the period of 2019-2029

The Red List II assessment contributes to commitments under the Convention on Biological Diversity (CBD), the EU Biodiversity Strategy, the UN Sustainable Development Goals, the EU Marine Strategy Framework Directive (MSFD), the EU Habitat Directive (HD), and the EU Nature Restoration Regulation (NRR).

The findings from the updated Red List II assessment are also essential for tackling related issues, such as assessing Marine Protected Areas (MPAs), evaluating and mitigating the effects of climate change, and accounting for ecosystem services in the ecosystem-based management of human activities.

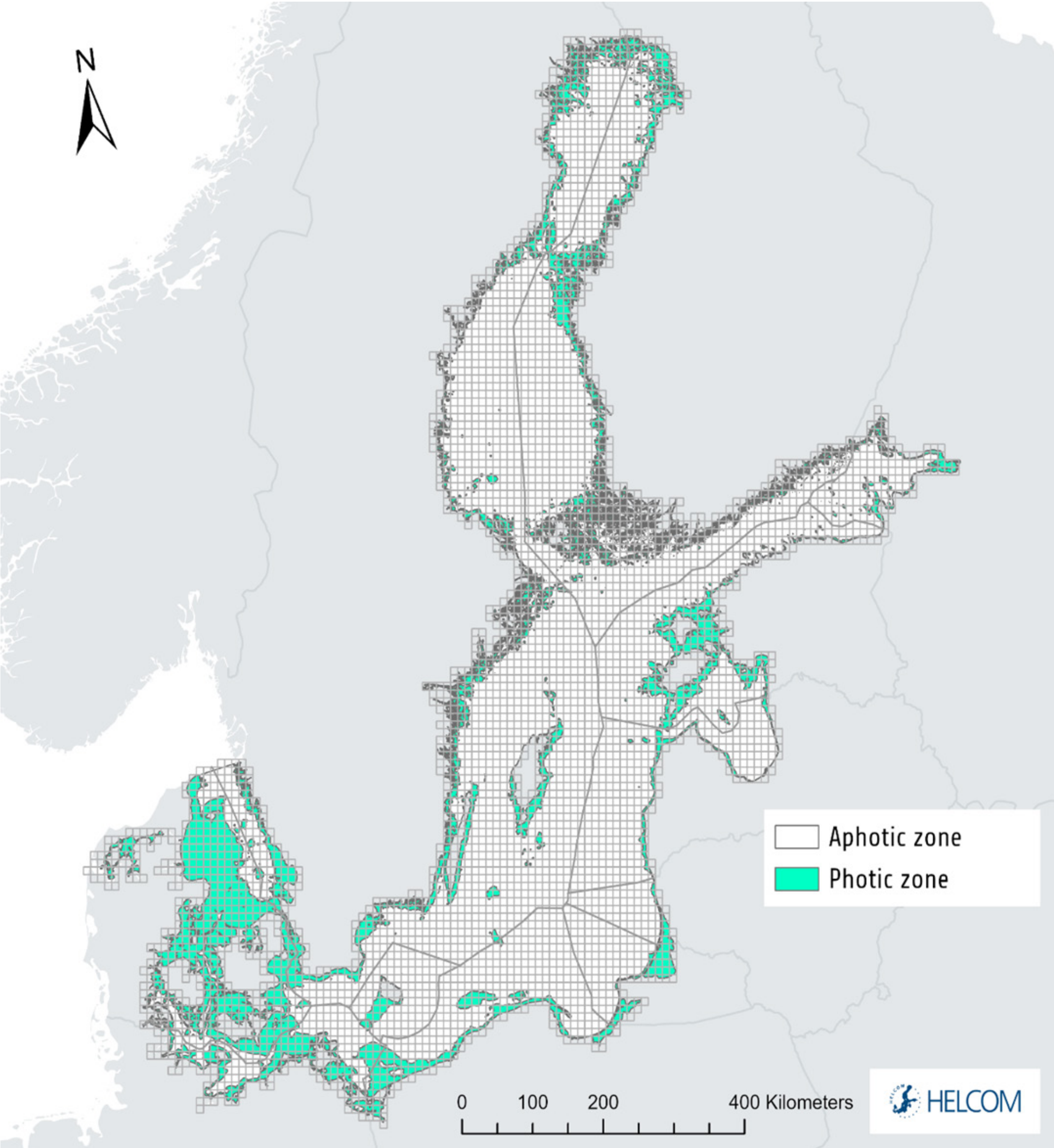

Figure 1. The photic and aphotic zones in the Baltic Sea with a 10x10 km European Environment Agency reference grid and coastal countries Exclusive Economic Zone borders (data from EUSeaMap, 2023).

Table 1. Red List II contribution to BSAP actions.

	BSAP Action	Red List II contribution
B7	Ensure that by 2030 the HELCOM marine protected area (MPA) network amongst other things provides specific protection to species and biotopes listed as regionally threatened or near threatened in the HELCOM Red Lists.	List of regionally threatened biotopes, habitats and biotope complexes available in Annexes 1-3 of this Report. List of regionally threatened species is available in the Red List II species Report.
B9	By 2024 assess the status of the Haploops species and the biotopes, as well as key threats and, if relevant based on the assessment, by 2026 develop a joint conservation plan for Haploops species including jointly agreed measures to improve the status of the species and biotopes, to be implemented by 2028.	- Contracting Parties conservation measures are listed in Table 13-Table 15 of this Report. - AB.H1I2 Baltic aphotic muddy sediment dominated by *Haploops spp.* habitat status is available in Annex 1 of this Report. - *Haploops tenuis* and *Haploops tubicola* species status is available in Annex 3 of the Red List II species Report.
B23	By 2025, develop, and by 2027 implement, and enforce compliance with ecologically relevant conservation plans or other relevant programs or measures, limiting direct and indirect pressures stemming from human activities for threatened and declining species. These will include joint or regionally agreed conservation measures for migrating species.	Contracting Parties national actions on threatened habitats have been compiled in this Report (Table 13 - Table 15) and recommendations based on the implementation overview listed in Table 19.
B24	Develop tools for and regularly assess the effectiveness of other conservation measures for species besides marine protected areas (MPAs), with the first assessment to be done by 2025, as well as assess the effect on species through risk and status assessments by 2029.	Contracting Parties national actions on threatened habitats have been compiled in this Report (Table 13 - Table 15) and recommendations based on the implementation overview listed in Table 19.
B28	Update the HELCOM Red List Assessments by 2024, including identifying the main individual and cumulative pressures and underlying human activities affecting the red-listed biotopes and habitats.	Red List assessments updated with this Report.
B29	By 2025 develop, and by 2027 implement, and ensure compliance with, ecologically relevant conservation plans or other relevant programs or measures, limiting direct and indirect pressures stemming from human activities for threatened and declining biotopes and habitats.	Threats to biotopes, habitats and biotope complexes have been compiled (Figure 22 and Table 11 of this Report).
B30	Develop tools for and regularly assess the effectiveness of other conservation measures for habitats and biotopes besides marine protected areas (MPAs), with the first assessment to be done by 2025, as well as assess the effect on biotopes and habitats through risk and status assessments by 2029.	Summary of Contracting Parties actions on threatened species and habitats have been compiled (Table 13 - Table 15) and recommendations made based on 2024 red-list assessment results (Table 19 of this Report).
B32	Update the HELCOM Underwater biotope and habitat (HUB) classification where gaps have been identified by 2024, and by 2025 develop a fully functioning translation matrix between HUB, Marine Strategy Framework Directive (MSFD) broad habitat types, Habitats Directive habitats and the European Nature Information System (EUNIS), in co-operation with the European Marine Observation and Data network (EMODnet).	HUB has been updated in 2024 with recommendations (Leinikki, J. 2024). Translation matrix has been developed in 2024 with recommendations.
HT9	Map biotopes and habitats nationally based on regionally comparable classification systems, including key habitats and habitats forming species, and identify gaps in spatial coverage of mapping efforts, with the aim to produce Baltic-wide models, including production of maps, of distribution of habitats and biotopes by 2028.	Available data for biotopes and habitats has been collated by Red List II project. Red List II maps have been published in HELCOM MADS.
HT10	Target the gaps identified in the HELCOM monitoring programmes of biotopes, habitats, including key habitats and key habitats forming species by 2024 and operationalize continual Baltic-wide monitoring of those biotopes and habitats by 2030.	Available data for biotopes and habitats has been collated by Red List II project (Annexes 1-3 of this Report).
HT11	Develop quality standards for seafloor habitat mapping and derived products by 2024.	Available data for biotopes and habitats has been collated by Red List II project.

1. Habitat assessment

1.1. HELCOM Guidelines for Red List assessment and use of Categories and Criteria for Habitats

The HELCOM Red List II work is based on the IUCN Red List Criteria and aims to align the regional assessment with IUCN guidance whenever possible. All rules and definitions outlined in the IUCN Red List of Ecosystems Guidelines (IUCN, 2017) apply at the regional level, unless otherwise stated, and the IUCN documents and guidelines should be consistently referenced. However, due to the diverse range of circumstances encountered when assessing different taxonomic groups in various regions, it is not always possible to strictly adhere to every aspect of the IUCN Guidelines. Some level of interpretation is inevitable, and these decisions are left to the discretion of the regional Red List compilers.

During the Red List II project, the HELCOM Guidelines for Red List assessment and the use of Categories and Criteria for Habitats was developed based on the criteria developed by IUCN (Bland, L.M., Keith, D.A., Miller, R.M., Murray, N.J. and Rodríguez, J.P. (eds.), Version 1.1 (2017) and previous HELCOM Red List assessment, with adjustments for the specificities of the Baltic Sea region. These guidelines provide instructions for all parties involved in updating the regional Red List assessment, ensuring consistency across assessments and topics, and enabling assessors to draw from the relevant experiences and discussions of other assessment topics. The HELCOM Guideline was used as a living document and was updated during the project as necessary (version 5.10.2023, available from the Secretariat).

The IUCN Red List of Ecosystems (RLE) approach allows for assessments for threat of habitat collapse at different geographic scales. Global assessments encompass all occurrences of an ecosystem type worldwide, informing international conservation efforts. Sub-global assessments, defined by political or ecoregional boundaries, are also possible and the HELCOM Red List is such an example. The HELCOM Contracting Parties efforts to create a regional assessment of the Baltic Sea is a unique effort in scope and level of ambition for a marine area.

1.2. Regional concept

While specific regional guidelines are still under development by IUCN, general rules apply to sub-global RLE assessments (Rodríguez *et al.* 2015). These include a comprehensive description of the assessed ecosystem and its defined area (with maps or spatial data). Crucially, the core RLE criteria (A, C, D, and E) and their associated thresholds, time frames, and data requirements remain unchanged in regional assessments. The application of sub criterion B2 (concerning the extent of occurrence found within a 10x10km grid of the geographic location), also remains unchanged, using a minimum convex polygon encompassing all occurrences. Research addresses the refinement of Criterion B at this regional-scaled assessment along with showcasing the pressures present in the Baltic Sea to be applied to an assessment based on criterion C.

Regular status reviews of Baltic Sea species and habitats/biotopes track long-term biodiversity trends and identify changes, informing conservation plans and environmental measures for at-risk entities. Red List assessments support Baltic Sea regional commitments, improving the effectiveness and efficiency of measures by prioritizing areas and species. The aim is not to assess all habitats and biotopes that have ever occurred in the Baltic Sea area, but to focus on those that are currently existing in, or within the timeframe outlined by the assessment guidance that have existed or strongly depend on the Baltic Sea marine or coastal area.

This regional assessment complements, rather than replaces, national Red List efforts conducted by individual Contracting Parties. While national lists assess threats within specific country boundaries, this HELCOM assessment provides a pan-Baltic perspective. Consequently, differences in threat classifications between this regional list and national lists may occur due to the differing scales of analysis. Such divergences reflect distinct viewpoints and pressures relevant to regional versus national contexts, and both assessments provide correct and relevant information guiding conservation efforts at their respective levels.

HELCOM's Red List assessment focuses on the entire Baltic Sea, using 10x10 km grid cells to represent known biotope occurrences (Figure 2). HELCOM does not conduct sub-basin specific RLE assessments, due to data limitations and to avoid imposing ecologically irrelevant boundaries.

A core principle of the project was to prioritize a data-driven approach over expert opinion in the assessments. This was intended to ensure objectivity, reproducibility, the ability to quantify trends, and the capacity to track changes over time – all crucial elements for a credible and effective Red List assessment. These data-driven principles were intended to strengthen the assessment's impact on conservation policy and management. Due to data deficiencies the scope and number of biotopes that could be assessed were greatly reduced and decrease the evidence-base created in the project. The resulting reliance on expert opinion, while valuable, introduces a degree of subjectivity that the project initially aimed at minimizing. This data gap highlights the critical need for enhanced monitoring efforts and data collection across the Baltic Sea to support future, more robust Red List assessments. The limitations imposed by data scarcity should be noted and considered when using the current assessment's findings.

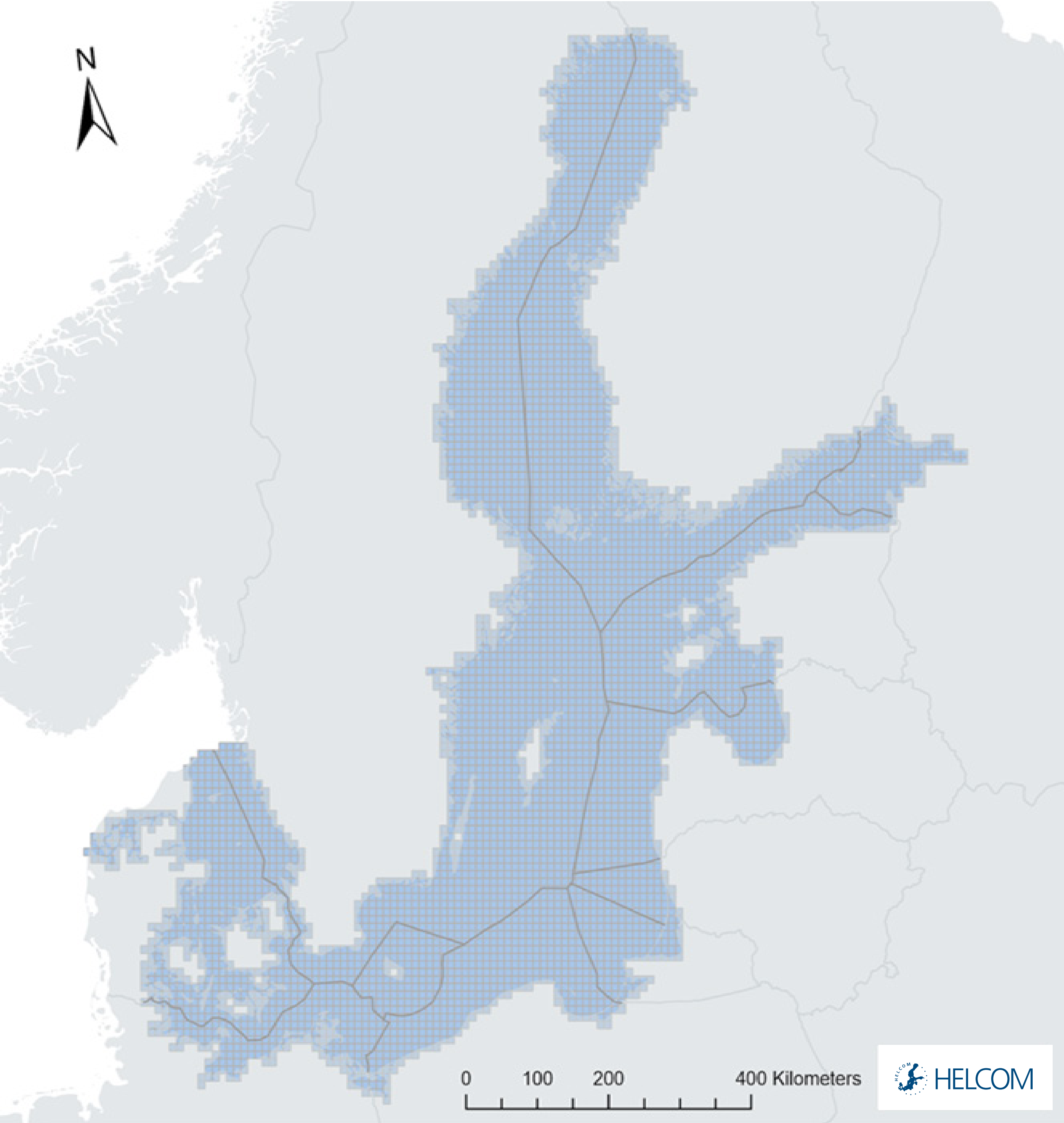

Figure 2. The entire HELCOM area is considered in the Red List assessment using a 10x10 km grid that is also sectioned based on the Exclusive Economic Zones (EEZ) of the coastal countries.

1.3. Threat categories

HELCOM Red List threat assessment of habitats and biotopes uses the categories described in the IUCN Red Lists of Ecosystems Categories and Criteria (Figure 3).

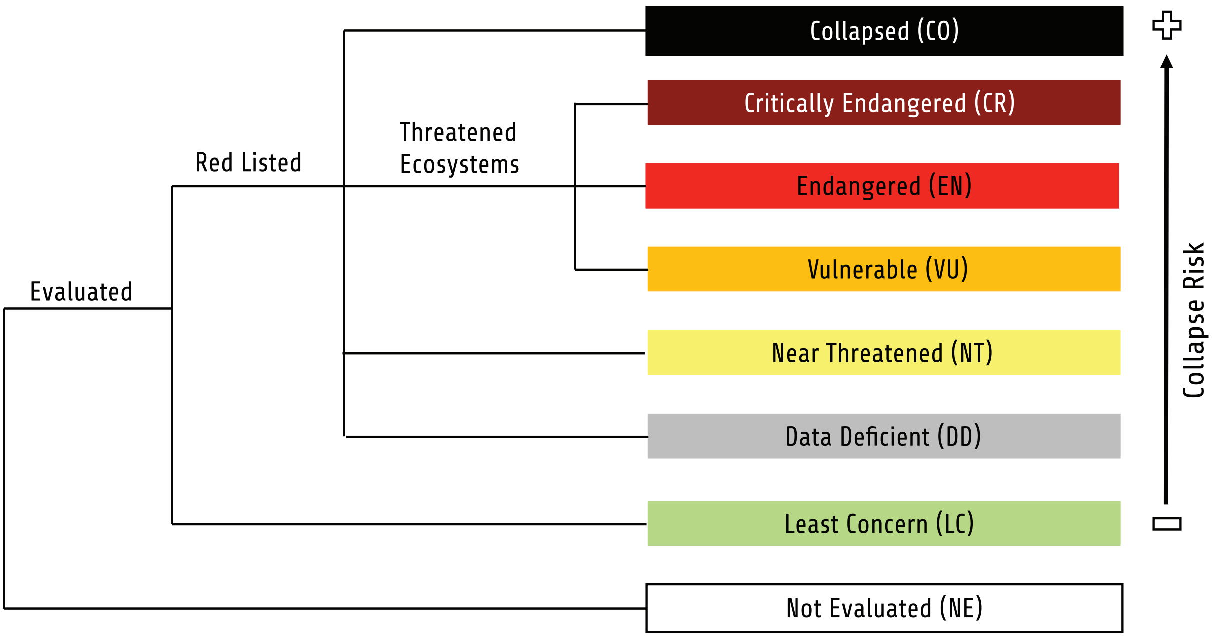

Figure 3. The Red List threat categories.

Biotopes are categorized based on the probability of the biotope 'collapsing' in the Baltic Sea; this probability is quantified by the decline in quantity and/or quality of the biotope as adapted from Keith *et al.* (2013) (Table 2). The more severe the decline has been or the higher it is predicted to become, the more threatened the biotope is perceived to be and the higher the assigned threat category. Only one threat category can be assigned per biotope.

Biotopes that have completely disappeared from the Baltic Sea are categorized Collapsed (CO). Collapse may occur when most of the diagnostic components of the characteristic native biota are lost from the system, or when functional components (biota that perform key roles in ecosystem organization) are greatly reduced in abundance and lose the ability to recruit. If a biotope has been categorized CO, this implies that the biotope has been adequately searched for - it has previously been present in the survey area, but during the assessment it can no longer be proven to exist.

The last two categories (DD and NE) do not reflect the threat status of a habitat or biotope. The category Data Deficient highlights habitats/biotopes for which sufficient information is lacking to make a sound status assessment. The inclination to assess a habitat or biotope as Data Deficient may be very strong; it should be emphasized that assessors must use all data available in full when making a Red List assessment. Precise information on scarce habitats and biotopes are usually lacking, and although the criteria are as quantitative and defined as is possible at the time of the publication of these guidelines, one can use projections, assumptions, and inferences in order to place a habitat or biotope in the appropriate category for those habitats and biotopes that are lacking exact data. Since Data Deficient is not a category of threat, habitats and biotopes placed in this category are not so obviously targets for conservation action, although their needs might be very great. Assessors should use whatever information is available and relevant to make assessments and place a habitat or biotope into the Data Deficient category only when there is really no alternative. The category Not Evaluated applies to taxa that has not yet been evaluated against the Red List Criteria.

Taxa in all of the Red List Categories, except LC and NE, are normally presented in the published Red List and, consequently, are referred to as "red-listed". The Red List of Baltic Sea Habitats and Biotopes will include a listing of all habitats and biotopes assessed as LC and information about them will be documented, although these would not be referred to as "red-listed". This is especially important, for example, for taxa that were Red-listed in an earlier HELCOM Red List, but have since been down-listed, either as result of a genuine change in status or as a result of a change of assessment methodology.

Table 2. Description of the threat categories.

Category		Description
Collapsed	**CO**	The biotope is no longer known to occur in the Baltic Sea; the biotope does not retain its defining features; and characteristic biota performing key functions is no longer retained.
Critically Endangered	**CR**	The best available evidence indicates that the biotope meets any of the Red List criteria for Critically Endangered and it is therefore considered to be facing a very severe risk of collapse throughout its distribution.
Endangered	**EN**	The best available evidence indicates that the biotope meets any of the Red List criteria for Endangered and it is therefore considered to be facing a severe risk of collapse throughout its distribution.
Vulnerable	**VU**	The best available evidence indicates that the biotope meets any of the Red List criteria for Vulnerable and its therefore considered to be facing a moderately severe risk of collapse throughout its distribution.
Near Threatened	**NT**	The best available evidence indicates that the biotope meets any of the Red List criteria for Near Threatened and it is therefore considered to be facing a moderate risk of collapse throughout its distribution.
Data Deficient	**DD**	A habitat or biotope is Data Deficient when there is inadequate information to make a direct, or indirect, assessment according to the Red List criteria. Listing a biotope in this category indicates that more information is required and that future research might categorize the biotope in one of the categories indicating that the biotope is threatened.
Least Concern	**LC**	The habitat or biotope is Least Concern when it unambiguously meets none of the criteria threshold values for red-listed categories and it is therefore currently not seen to face a risk of collapse throughout its distribution.
Not Evaluated	**NE**	A habitat or biotope that has not yet been evaluated against the criteria. This criterion has been applied e.g. for Level 5 biotopes for which lower Level 6 biotopes have been evaluated.

1.4. Criteria

The IUCN RLE risk assessment model has 5 criteria in place for assessing the risk of ecosystem collapse (Table 3).

Table 3. The IUCN RLE criteria.

Criterion	A	B	C	D	E
	Reduction in distribution	Restricted distribution	Environmental degradation	Disruption of biotic processes	Quantitative analysis
Purpose	Identifies ecosystems that are undergoing declines in area, most commonly due to threats resulting in ecosystem loss and fragmentation.	Identifies ecosystems with small distributions that are susceptible to spatially explicit threats and catastrophes.	Identifies ecosystems that are undergoing environmental degradation.	Identifies ecosystems that are undergoing loss or disruption of key biotic processes or interactions.	Allows for an integrated evaluation of multiple threats, symptoms, and their interactions.
Application	Extent over time: A1. Past 50 years A2a. Next 50 years A2b. Any 50-year period A3. Since 1750	Current extent: B1. EOO B2. AOO B3. Number of locations	Relative severity and extent: C1. Past 50 years C2a. Next 50 years C2b. Any 50-year period C3. Since 1750	Relative severity and extent: D1. Past 50 years D2a. Next 50 years D2b. Any 50-year period D3. Since 1750	Probability of collapse: CR ≥ 50% within 50 years EN ≥ 20% within 50 years. VU ≥ 10% within 100 years.

The assessment criteria used in this HELCOM Red List are designed for a Baltic Sea-wide evaluation. While these criteria can be applied at local, regional, or national levels, it's important to recognize that the resulting threat category for a given biotope might differ from the Baltic Sea-wide assessment due to scaling effects. A biotope classified as Least Concern (LC) at the Baltic Sea scale could be Critically Endangered (CR) on a national Red Listing level.

1.5. Classification system for biotopes, habitats and biotope complexes

This HELCOM Red List II threat assessment uses biotopes and habitats defined by the HELCOM Underwater Biotope and Habitat Classification System (HELCOM HUB) (HELCOM 2013c). HELCOM HUB defines biotopes based on substrate coverage, epibenthic biota, infauna, or absence of macrofauna, and the coverage/biomass of specific taxonomic groups. While the spatial scale isn't strictly defined, biotopes are typically measured in square meters at minimum, and the community must be functionally distinct.

Whenever assessing biotopes, the definition of such biotopes, using a classification system is necessary and molds the understanding of the boundaries. HELCOM HUB hierarchically classifies biotopes, favoring perennial, attached biota over annual biota. Assessments are primarily at HELCOM HUB Level 6 biotopes. Additionally, seven out of the ten biotope complexes identified in HUB and listed in the EU Habitats Directive Annex I were assessed.

The HELCOM HUB provides a standardized way to classify and understand the Baltic Sea's underwater environments. It defines a ***biotope*** as the combination of a ***habitat*** (the abiotic environment, defined by factors like seabed type and its associated biotic community of species (Connor *et al.* 2004, Olenin & Ducrotoy 2006). ***Biotope complexes*** are landscape-scale units composed of multiple interacting biotopes and habitats. In HELCOM HUB, levels 1-3 generally describe habitats, while levels 4-6 describe biotopes.

HELCOM HUB, developed by national experts using extensive biological data, employs a hierarchical structure. This hierarchical approach, common in biological classification, organizes biotopes based on their similarities and differences along environmental gradients. Broad-scale factors, like light availability (photic vs. aphotic), are placed high in the hierarchy, while finer-scale distinctions, like species composition, are lower. HELCOM HUB is a hierarchical classification system that delineates biotopes using split rules (Figure 4).

While biotopes are typically identified at a minimum scale of m^2, the exact scale isn't rigidly defined. A biotope should be large enough to function as a distinct ecological unit, with its community exhibiting specific functions. The identification is driven by biological and ecological relevance. HELCOM HUB aims to classify *all* Baltic Sea environments, including small areas with rare biotopes, *as explained in the rare biotopes segment.*

1.6. HELCOM HUB and EUNIS classification system compatibility

HELCOM HUB is intended to be compatible with the EUNIS habitat classification system (specifically EUNIS 2012 and was later incorporated), through translational matrices. The EUNIS benthic classification's first division is based on biological zones (depth-related) and substrate. Level 3 reflects biogeographical regions (Arctic, Baltic, Atlantic, Mediterranean, Black Sea), based on salinity and temperature. While cross-referencing to the Habitats Directive Annex I and the European Red List of Habitats is available, the cross-referencing of EUNIS needs to be revisited. This compatibility with EUNIS and other frameworks (like MSFD) facilitates communication and broader assessments across the Baltic Sea region and beyond. In comparison, HELCOM HUB is a hierarchical classification system that delineates biotopes using split rules (Figure 4). Translational matrices are tools used to link and compare different habitat classification systems like HELCOM HUB, EUNIS, MSFD and NRR, enabling alignment of assessments. However, these matrices have limitations due to inherent differences in classification rules. A key challenge in translating between EUNIS and HELCOM HUB is their handling of the hydrodynamic gradient: EUNIS uses a theoretical, geographically assigned approach, whereas HUB relies on in-situ sampling, potentially causing classification mismatches. Further work, potentially including revisions to split rules in either system, is needed to further improve alignment.

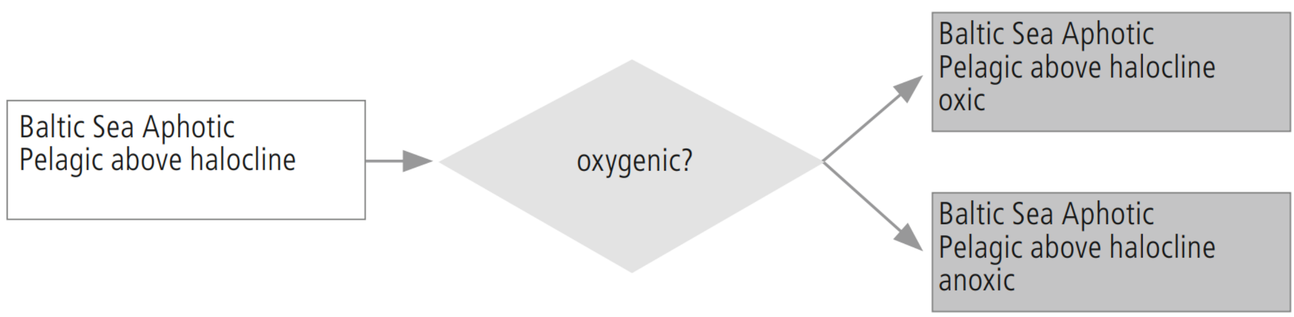

Figure 4. Example of how the hierarchical structure of the HELCOM Classification of habitats and biotopes functions.

1.7. HELCOM HUB update

The HELCOM HUB classification system was designed to be updated to include newly identified biotopes, ensuring that it can cover 100% of the Baltic Sea and that even rare biotopes can be classified. The HUB update was done by Alleco Ltd during the Red List II project (Leinikki, J. 2024).

For the current Red List II project, the short-term update to the HUB classification involved adding newly discovered biotopes identified through data analysis. This process included incorporating substrate-biota combinations that were not previously included in the HUB classification. The update specifically added:

- 8 new HUB Level 5 biotopes based on the analysis of Estonian, Swedish, and Finnish data.
- 15 new HUB Level 6 biotopes based on the analysis of German data.

This update aimed to improve the comprehensiveness of the HUB classification by including previously unrepresented biotopes. It focused on adding new biotopes rather than modifying existing split-rules or other aspects of the classification system. This approach was chosen due to the relative simplicity of adding new biotopes, which mainly involved updating the HUB folder structure and the BSEP publication. More complex updates, such as modifying split rules, were deferred for future consideration.

The integrated assessment of the status of benthic habitats, the Baltic Sea seafloor is divided based on 18 benthic broad habitat types (BHTs), in line with EUNIS classification used under EU MSFD. The spatial division is based on substrate and depth zone and the spatial presentation of the BHTs originate from the EUSeaMap 2021 data and cover the whole Baltic Sea region. As they cover the whole region, the BHT map ensures that there is at least one habitat in all parts of the assessment area. All 18 Broad habitat types are included in HOLAS 3, as compared to eight that were included in HOLAS II.

1.8. Rare biotopes

The Red List assessment prioritizes the inclusion of rare biotopes, recognizing their heightened vulnerability. These biotopes are often poorly documented in existing datasets; thus, efforts were made to gather information on them through dedicated data calls. The overarching goal of the Red List is to identify biotopes facing the risk of "collapse" – a fundamental shift in identity, loss of characteristic features, and replacement by an entirely new ecosystem (Keith *et al.*, 2013). Biotopes found only in a few locations or on rare substrates within the Baltic Sea are particularly susceptible to collapse, even from relatively minor or localized pressures. Therefore, assessing these rare biotopes is paramount for a complete understanding of threats to Baltic Sea biodiversity. With the highly varied nature of the Baltic Sea, where the physiological conditions change throughout the regions of it, certain biotopes are of different national considerations when defining the rarity of habitats, e.g. substrates makeup of the benthic floor. Efforts to enhance the understanding of the current state of these rare biotopes have been taken into consideration throughout the analysis and examined rigorously wherever possible.

2. Red List II assessment results

2.1. Biotope complexes assessment

The analysis of biotope complexes was carried out based on IUCN criterion C, using the SPIA methodology as good data coverage allowed for this method to be applied.

The rare biotope complex, Submarine structures made by leaking gases, was furthermore possible to assess also using IUCN criterion B2, as the limitation of this complex is situated in the Kattegat between Sweden and Denmark and is restricted in extent.

The Red List II 2024 assessment of Baltic Sea biotope complexes reveals a concerning trend of degradation for several key habitats (Table 4). Compared to the 2013 assessment, several biotope complexes have experienced a decline in status, highlighting the escalating pressures on these valuable ecosystems. The total list of the biotope complexes and the categories assigned to them are available in Annex 3 of this report.

Overall, the Red List II 2024 results paint a daunting picture for Baltic Sea biotope complexes. The biotope complexes have experienced a decline and thus an increase in the risk of collapse. This underscores the dynamic nature of these ecosystems and the complex challenges that need to be addressed for their conservation, expressed by various anthropogenic sources of accumulative pressures.

The lack of data for certain biotope complexes complicates the assessment and highlights the need for increased research and monitoring efforts. These findings serve as a call to action for strengthened conservation measures to protect and restore these vital components of the Baltic Sea ecosystem.

Table 4. Threat category of biotope complexes based on IUCN criteria C results from the analysis with a comparable threat category from the Red List 2013 project. Note that Boreal Baltic narrow inlets results are missing, which is due to not being in the SPIA catalogue of ecosystems that it analyzes. Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Threat category Red List II 2024	HUB code	BIOTOPE COMPLEX	Threat category Red List 2013
EN	1130	Estuaries	CR
EN	1140	Mudflats and sandflats	VU
EN	1150	Coastal lagoons	EN
VU	1160	Large shallow inlets and bays	VU
EN	1180	Submarine structures made by leaking gases	EN
EN	1610	Baltic esker islands	NT
VU	1620	Boreal Baltic islets and small islands	NT

2.1.1 Assessment process

Assessment method for IUCN criterion C using the HELCOM Spatial Distribution of Pressures and Impacts tool

The Baltic Sea faces numerous pressures from human activities, both terrestrial and marine, originating within its catchment area. While individual pressures might seem minor, their cumulative impact can be substantial, particularly on sensitive species or habitats. The HELCOM Spatial distribution of Pressures and Impacts Assessment (SPIA) tool addresses this cumulative burden by evaluating the combined effects of human activities across the region.

At the time of the Red List II project, SPIA uses data layers from the HELCOM third Holistic Assessment (HOLAS 3), comprising 17 aggregated pressure layers, to calculate spatial pressure and impact indices. These layers can be analyzed together or in specific combinations to assess biotope complexes. SPIA incorporates expert-validated, nationally recognized sensitivity scores (from the HOLAS 3 SPIA assessment) to quantify ecosystem vulnerability, providing insights into pressure impacts over a six-year period (2016-2021).

The Spatial Pressure Index (SPI) within SPIA quantifies the cumulative pressures from human activities. These activities are grouped into themed pressure layers (e.g., "Physical Disturbance," which includes activities like sand extraction, wind farms, and shipping). Each pressure layer's impact on a specific biotope complex is weighted by a unique sensitivity score, preventing the overestimation of widespread but low-impact pressures.

To apply HOLAS 3 data to assess biotope complexes and data sufficient HELCOM HUB classes under IUCN Criterion C, several adaptations were made. Because HOLAS 3 data cover only six years (2016-2021), one assumption made in this Red List assessment is that these pressures represent a relatively constant condition over the 50-year timeframe required by IUCN Criterion C, particularly for sub-criteria C1 and C2B (see Past, current and future threats segment). To assess major threats for specific Biotope complexes using IUCN criterion C1, threats were matched with relevant SPIA pressure layers. Clarifying the relationships between specific threats and broader SPIA pressure layers (e.g., "Physical Disturbance Pressure" encompasses multiple underlying pressures, likewise, "Physical Loss Pressure Layer" includes human activities that cause seabed loss, and "Disturbance of Species Due to Human Presence Pressure" stems from sources that probably include tourism activities).

The spatial extent of certain pressures, notably eutrophication and hazardous substances, is considered ubiquitous across the Baltic Sea (as represented in the SPIA tool). Therefore, their *severity*, rather than their presence, is used to assess their distribution and impact in this Red List assessment. The spatial extent of other pressures is calculated based on the number of 1x1 km point observations where the pressure is present (Figure 5).

To quantify pressure impact, a Theoretical Maximum Pressure (TMP) is calculated, representing the maximum potential impact of any pressure on a habitat. In SPIA, TMP is standardized to 1. Pressure values, adjusted by sensitivity scores, are averaged across the 10x10 km grid cells of a biotope complex and compared to the TMP.

The selection of relevant pressures' accumulation found within the examined habitat or biotope complex is then compared to the TMP, yields a percentage reflecting the Relative severity (%). This value reflects the IUCN criterion C on environmental degradation over a specific period (see Table 5). In this assessment. The extent of the pressure is taken into consideration, but due to restrictions in the methodology, the extent won't reflect the threat category.

Table 5. Visualization of which threat category will be assigned by IUCN criterion C standards, based on what outcome from the methodology invoked in this assessment.

	Relative severity (%)		
Extent (%)	**≥ 80**	**≥ 50**	**≥ 30**
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

Available data

The data for this assessment has initially been reported under Article 17 of the EU Habitat Directive (via European Environment Agency's EIONET). With nine Contracting Parties of HELCOM having reported their biotope complexes, which create an almost full coverage of the Baltic Sea.

The temporal time frame from which the data is gathered is from 2013 to 2018. For the purposes of the HELCOM Red List II project, the area of occupancy of the biotope complex has been made to fit the EEA standardized 10x10km grid located within the Baltic Sea.

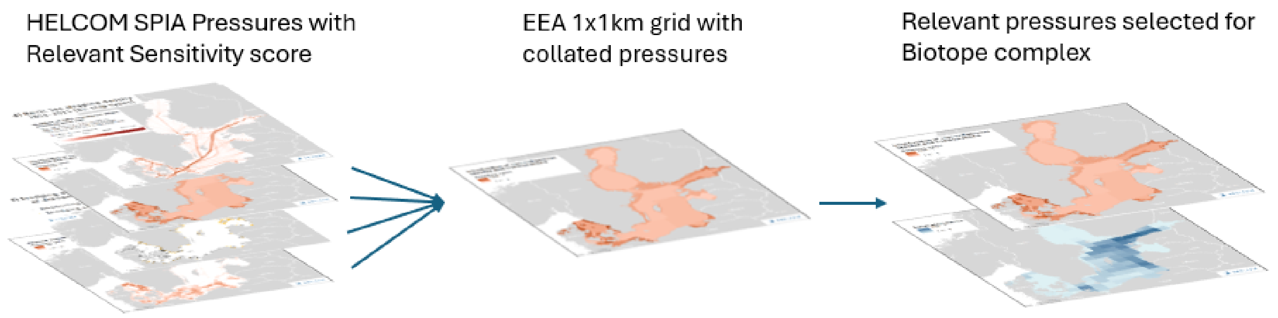

Figure 5. Visual representation of collating the HELCOM SPIA Pressures into a uniform grid in a 1x1km size which can be used to identify the relevant pressures' effect in the location of a selected habitat or biotope complex

2.1.2 Biotope complexes specific results

Estuaries (1130)

While estuaries show signs of improvement, it is difficult to conclude with certainty on whether this is due to a change in assessment method (from expert- to data driven) or whether it is due to actual positive developments in nature due to implementation of relevant legislation and other measures (Figure 6).

Estuaries, previously listed as Critically Endangered in 2013, have shown slight improvement, now classified as Endangered. The continued Endangered status underscores the ongoing vulnerability of these habitats, as the catchment area around the Baltic Sea has hazardous substances and nutrient enriched waters carried through riverine sources to these locations.

Coastal and marine ecosystems, encompassing a variety of unique biotope complexes, are increasingly threatened by human activities. Estuaries, for instance, suffer from physical alterations to their geological formations and water flow, often stemming from upstream dams, residual buildings, and harbor developments. These alterations, coupled with eutrophication, pollution, and maritime traffic, severely impact estuarine macrofauna communities.

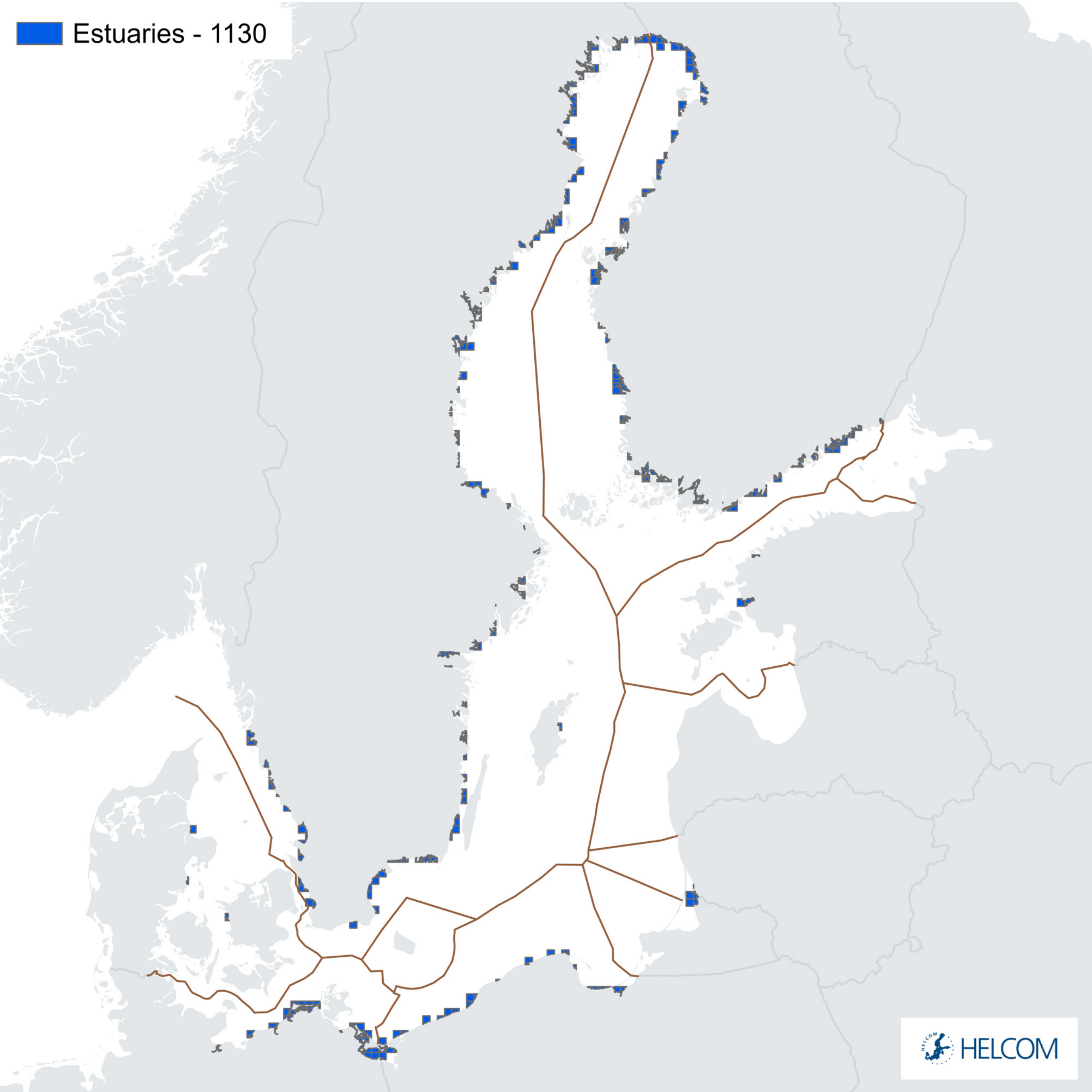

Figure 6. Distribution of Estuaries – 1130 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Submarine structures made by leaking gases (1180)

The Submarine structures made by leaking gases have retained their Endangered status from 2013 which indicates the knowledge of the pressures posed on this biotope complex to be continuous persistent threat and the need for continued conservation attention (Figure 7).

These submarine structures made by leaking gases are furthermore a rare occurrence on a regional scale, as they are only known to occur in the Kattegat sub-basin, this led to further examination, using IUCN criterion B2 methodology, which exacerbates the concern of this biotope complex's sensitivity.

Even unique Submarine structures made by leaking gases are not immune to human impacts. These fragile ecosystems are vulnerable to fishing activities, particularly bottom trawling and anchoring, as well as eutrophication. Contaminant pollution further harms their specialized macrofauna communities, while maritime traffic and offshore construction add to the pressures on these unusual habitats.

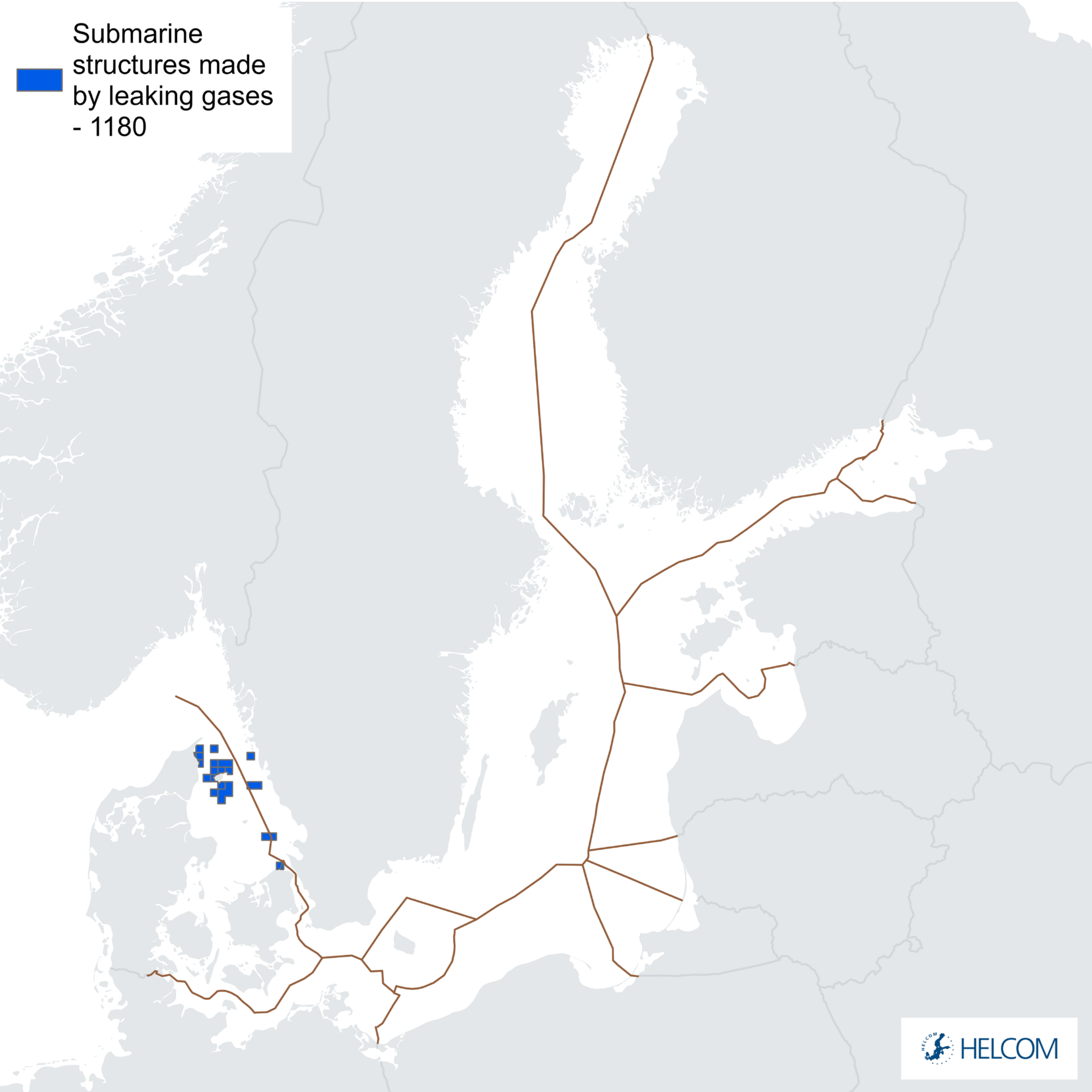

Figure 7. Distribution of Submarine structures made by leaking gases – 1180 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Large Shallow Inlets and Bays (1160)

Large shallow inlets and bays, with its vast presence in Danish and Swedish coastal areas and broad presence in the Baltic Sea region remain classified as Vulnerable, highlighting the ongoing challenges in safeguarding these extensive coastal features (Figure 8).

Large Shallow Inlets and Bays experience the cumulative impacts of tourism, aquaculture (including mussel dredging), the pervasive practice of dredging and dumping dredged material, and widespread coastal and marine construction. These activities, combined with the ever-present threats of contaminant pollution, eutrophication, and general pollution, contribute to the ongoing degradation of these expansive habitats.

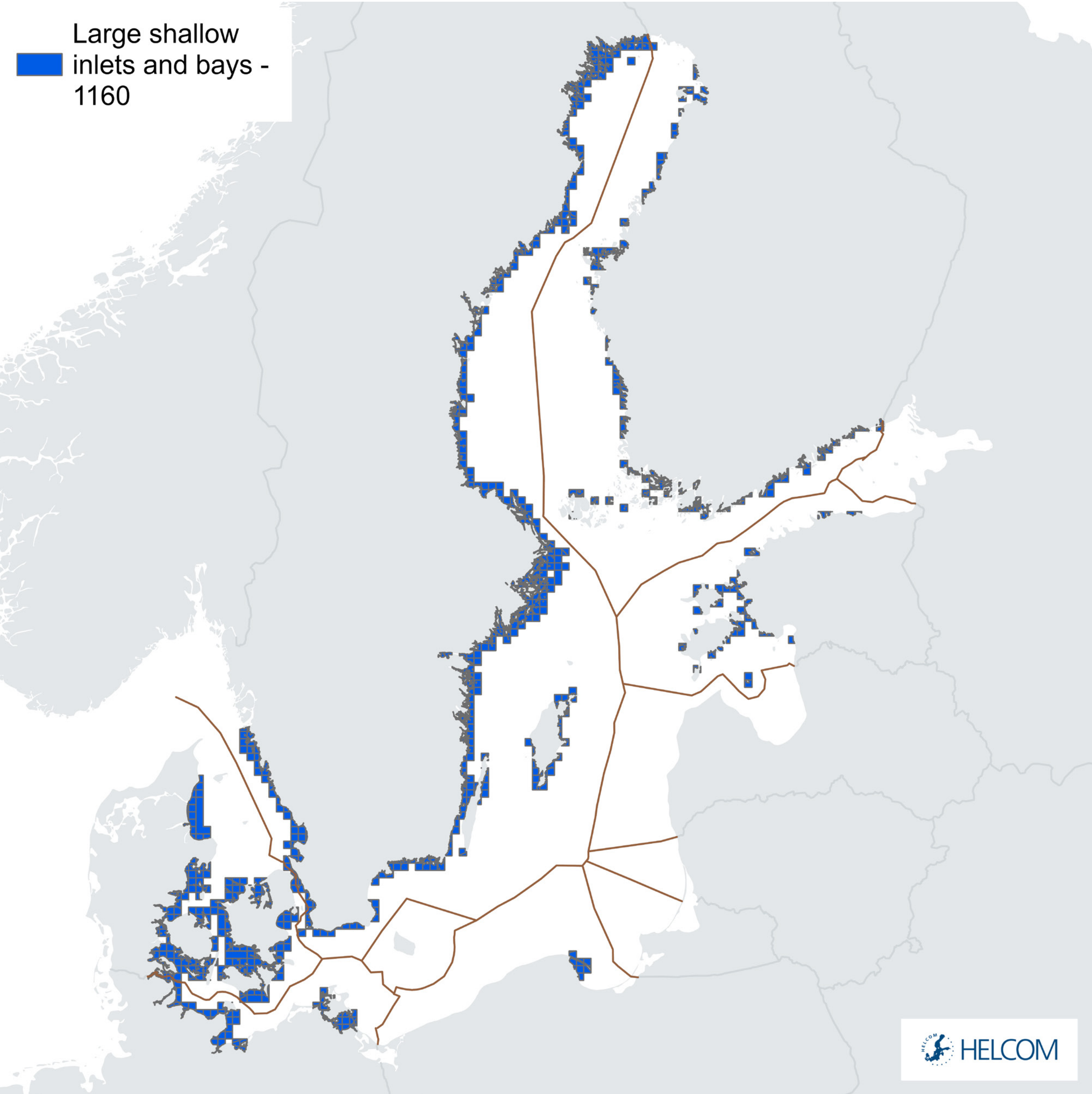

Figure 8. Distribution of Large shallow inlets and bays – 1160 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Coastal lagoons (1150)

The broad extent throughout the Baltic Sea, Coastal lagoons – 1150 (Figure 9), are susceptible to broad array of pressures, which varies in sub-basin scale. This emphasizes the strong need for a regional scale assessment of this biotope complex.

Worryingly, the results show a continuation of the threat category from 2013, to remain as Endangered. Although susceptible to many pressures, hazardous substances and eutrophication pose significant pressures onto this coastal biotope complex as non-point sources of pollution are hard to target and identify and can thus be hard to regulate. Limiting these pollutants is crucial in the efforts of legislative protection for these coastal lagoons found within the Baltic.

Coastal Lagoons face a comparable suite of challenges, including oil spills, construction, unsustainable fishing, and dredging, with mussel dredging posing a particular threat. The combined effects of eutrophication and contaminant pollution significantly endanger the macrofauna within these sensitive ecosystems.

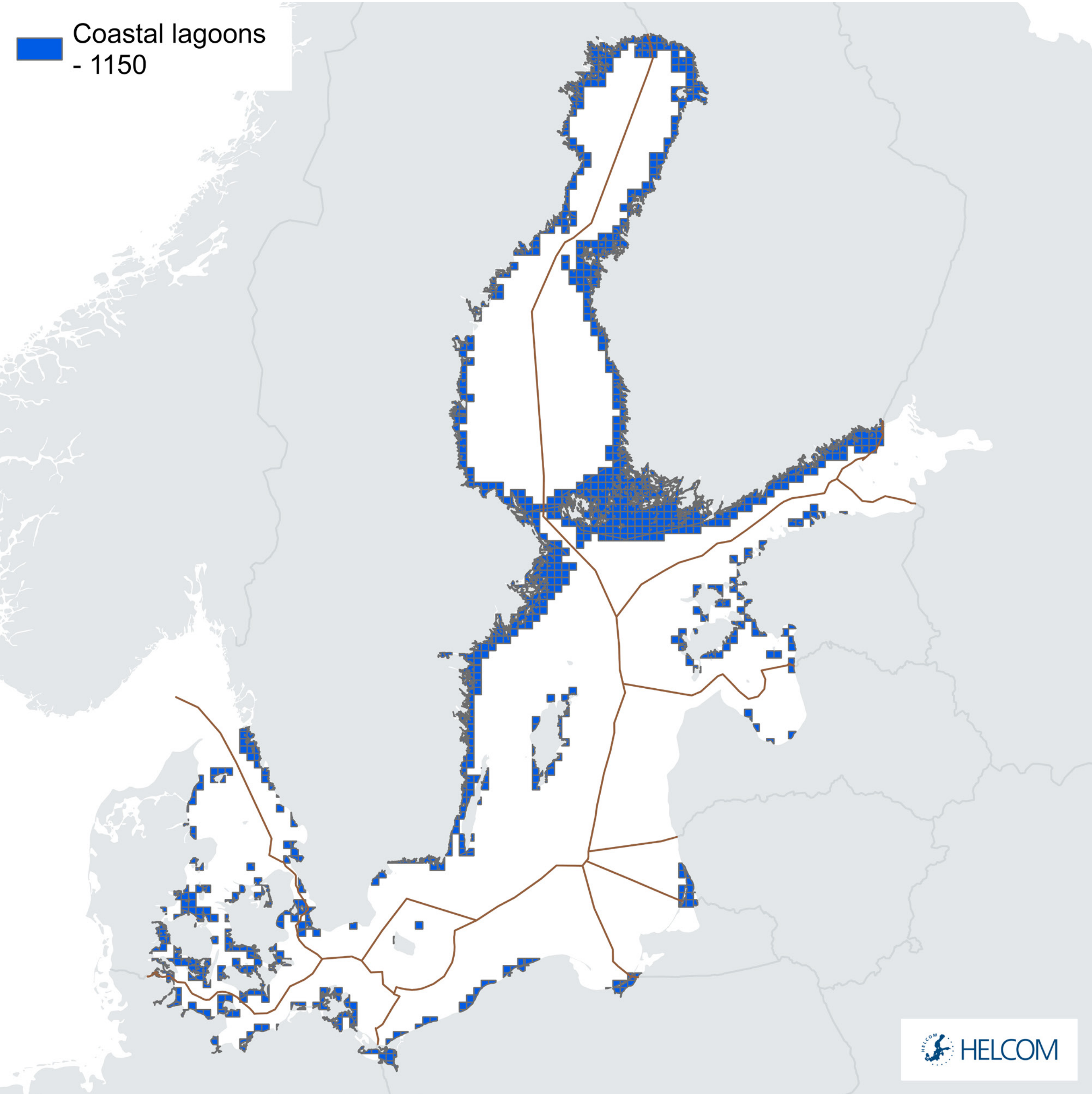

Figure 9. Distribution of Coastal lagoon – 1150 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Mudflats and sandflats (1140)

The Baltic Sea's Mudflats and sandflats that are not covered by seawater at low tide are widespread along Danish, German and Swedish coasts with some located in the inner parts of the Baltic Sea on the Estonian coast (see Figure 10).

These have deteriorated from Vulnerable (VU) in 2013 to Endangered (EN) in 2024, signifying a decline in the biotope complexes' health. Although the methodology of assessing this Biotope complex is different for the Red List II, it is worth emphasizing the pressures posed on these mud- and sandflats, as they're particularly vulnerable to physical disturbances e.g. dredging.

Mudflats and Sandflats are negatively affected by contaminant pollution, including oil spills, and the disruptive effects of coastal construction around lagoons. Unsustainable fishing practices and dredging projects, regardless of scale, exacerbate these pressures, while eutrophication and pollution further degrade these vital intertidal habitats.

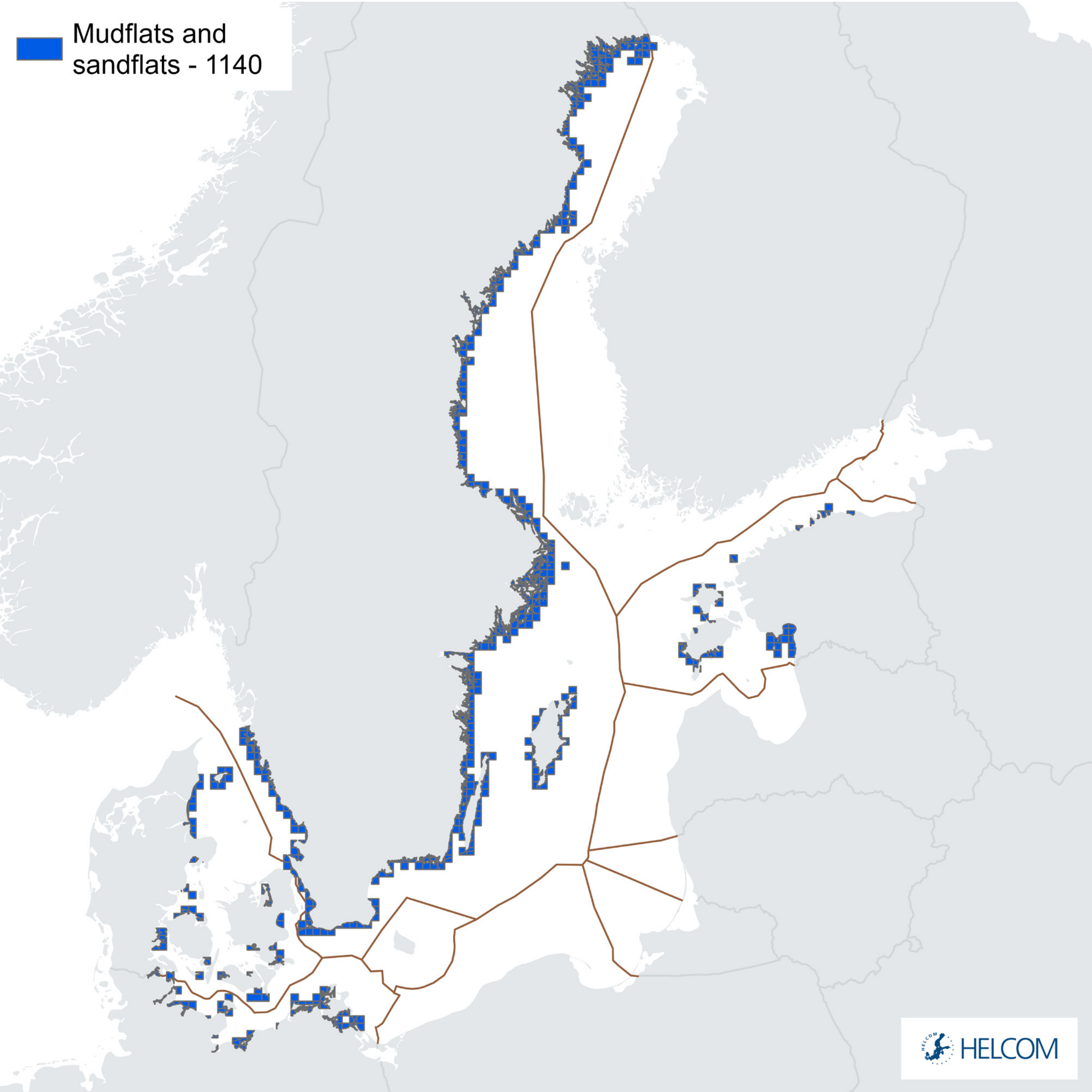

Figure 10. Distribution of Mudflats and sandflats – 1140 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Baltic esker islands (1610)

Similarly, The Baltic Esker Islands, located primarily in the northern parts of the Baltic Sea (see Figure 11), have been reclassified from Near Threatened in the 2013 Red List to Endangered in the current assessment. This significant increase in threat category stems from the pressures on this unique habitat and underscores the urgent need for targeted conservation actions to protect its remaining occurrences.

Among the major pressures impacting esker islands, hazardous substances are a significant concern, due to their ubiquitous nature.

Baltic Esker Islands, formed by glacial activity, are threatened by the dredging of shallow shores, the pressures of recreational activities, and various construction projects. Eutrophication and pollution compound these threats, jeopardizing the ecological integrity of these islands.

Figure 11. Distribution of Baltic esker islands – 1610 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Boreal Baltic islets and small islands (1620)

The Boreal Baltic islets and small islands have also experienced an increase in threat category, moving from Near Threatened (NT) in the 2013 HELCOM Red List to Vulnerable (VU) in the current assessment (Figure 12). This change indicates growing pressures on this habitat type, necessitating enhanced conservation efforts to safeguard its biodiversity and ecological integrity.

Like Esker islands, hazardous substances pose a considerable threat to the Boreal Baltic islets and small islands.

Boreal Baltic Islets and Small Islands are similarly imperiled by oil spills, offshore construction (especially wind farms) that alter hydrodynamics, dredging and dumping activities, and the impacts of tourism. Eutrophication and pollution further contribute to their decline.

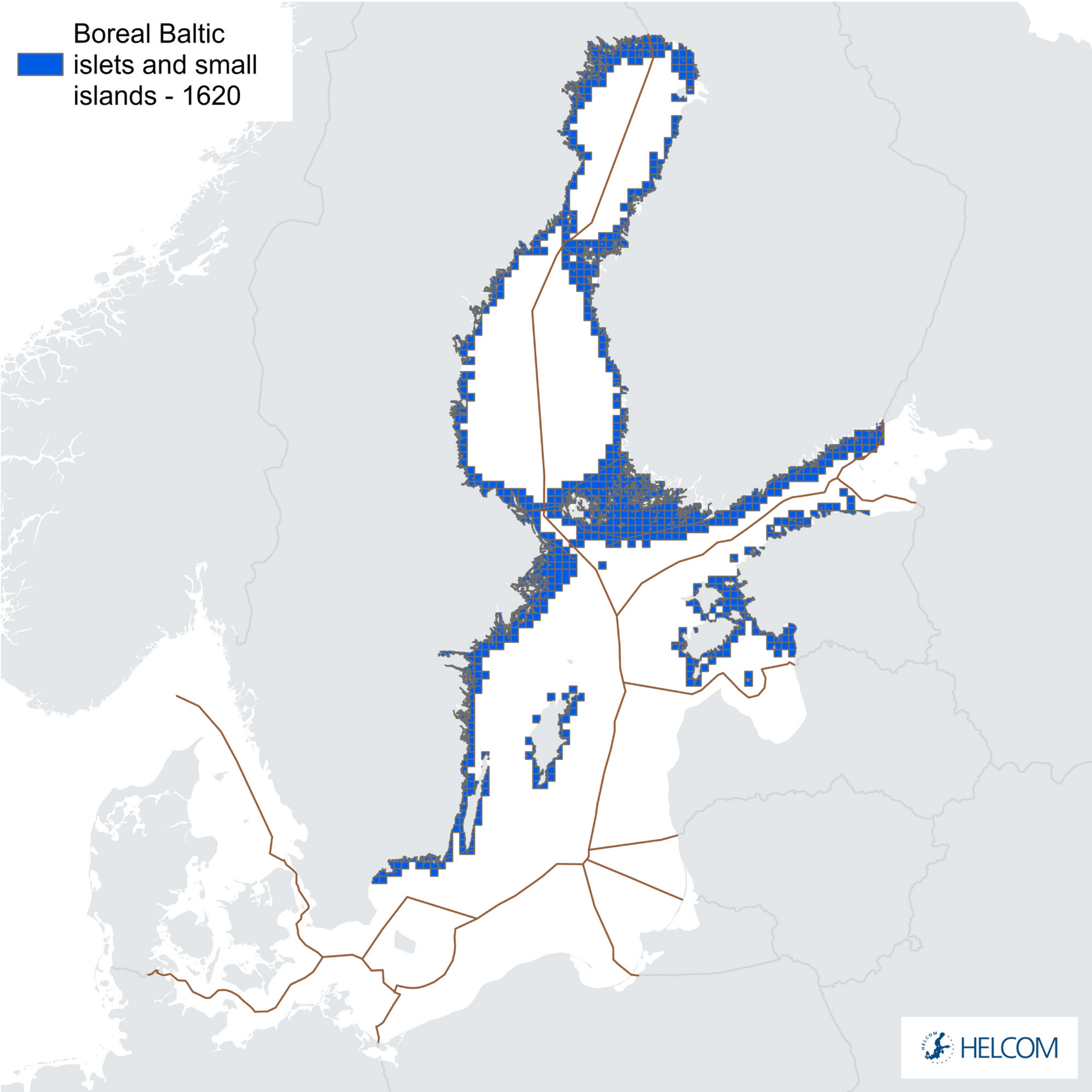

Figure 12. Distribution of Boreal Baltic islets and small islands – 1620 coverage results from the Habitat Directive reporting of 2018 fit into 10x10km standardized EEA grid cells which further has been intersected with the Baltic Sea's coastline (hence the varying shapes of polygons presented) and the Baltic sea's EEZ.

Sandbanks (1110), Reefs (1170) and Boreal Baltic Narrow Inlets (1650)

Three biotope complexes – Sandbanks and Reefs were not evaluated in 2024 due to many known occurrences not reflected in the dataset and some occurrences are now questioned for their accuracy. These matters stem from the Habitat Directive reporting and therefore limit further analysis on these biotope complexes.

Boreal Baltic narrow inlets were not eligible to follow similar assessment methodology as other biotope complexes, due to HELCOM SPIA tool not having validated sensitivity scores for that biotope complex, and therefore not possible to assess the biotope complex using IUCN criterion C. This invalidates the prospects of threat categorization for the 2024 Red List II project.

Sandbanks are threatened by sand and gravel extraction and are affected by offshore construction. Dredging (incl mussel dredging) and dumping of dredged material influences the sandbanks, as does the bottom trawling activities. Lastly, eutrophication and pollution impact the macrofauna community.

Relevant pressures for the reefs are stone extraction (mining and quarrying), dredging and dumping of dredged material and contaminant pollution. Fishing and tangled fishing equipment pose a threat to reefs as fish are often abundant around reefs. As sandbanks, also reefs are affected by eutrophication and pollution which impact the macrofauna community.

Boreal Baltic Narrow Inlets are impacted by infrastructure development, such as bridge construction, as well as by dredging, dumping, eutrophication, and the pervasive issue of contaminant pollution, all of which negatively affect the macrofauna communities residing in these constricted waterways.

2.2. Benthic habitat assessment

The version of HELCOM HUB classification system used in this assessment identifies 207 benthic biotopes in the photic zone and 115 in the aphotic zone, totaling 322 HUB classes (BSEP139 HUB). From the total list of 322 habitats 7 habitats were considered threatened (CR-VU) in the HELCOM Red List II assessment (Table 6) compared to the 15 threatened habitats in 2013. The total list of the benthic habitats and the categories assigned to them are available in Annex 1 of this report.

Table 6. List of benthic habitats categorized as threatened in Red List II and their respective categorization in 2013 Red List. Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Red List II 2024	Criteria 2024	HUB code	HUB name	Red List 2013	Criteria 2013
CR	A2b	AB.H1I2	Baltic aphotic muddy sediment dominated by *Haploops spp.*	EN	A1
EN	A2b	AB.H2T1	Baltic aphotic muddy sediment dominated by seapens	EN	A1
VU	B2	AA.J3L3	Baltic photic sand dominated by ocean quahog (*Arctica islandica*)	NT	A1
VU	B2, C1	AA.I1B7	Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*)	NT	A1
VU	B2, C1	AA.M1B7	Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*)	NT	A1
VU	B2, C1	AA.J1B7	Baltic photic sand dominated by common eelgrass (*Zostera marina*)	NT	A1
VU	B2	AA.J1Q1	Baltic photic sand dominated by stable aggregations of unattached Fucus spp. (typical form)	LC	A1

One habitat, Baltic aphotic muddy sediment dominated by *Haploops spp.*, was evaluated as Critically Endangered (CR) in 2024, previously as Endangered (EN). Baltic aphotic muddy sediments dominated by seapens remained as Endangered (EN) as in 2013. 5 habitats were categorized as Vulnerable in Red List II.

The proportion of category Not Evaluated (NE) was very high (Figure 13): 223 habitats (69.25%) in 2024 due to the lack of available data, compared to the 119 habitats in 2013 (36.96%). Previous assessment assigned 146 habitats category Least Concern (LC), current assessment has 53 habitats as Least Concern, this is because many habitats have in 2024 assessed from 2013 Least Concern into Data Deficient and Not Evaluated category due to the data limitations.

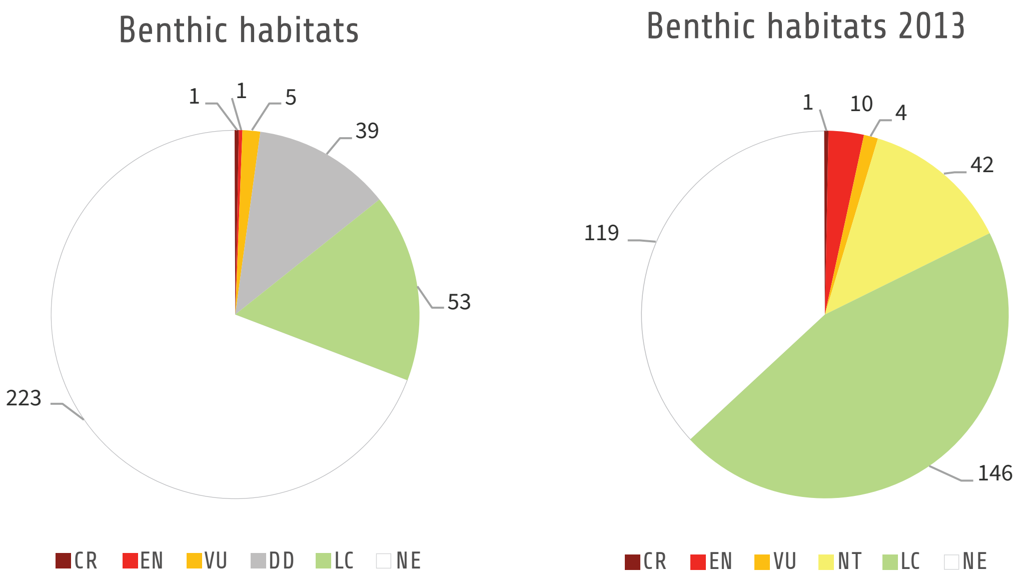

Figure 13. Proportions of Red List categories within the assessed benthic habitats in 2013 and 2014 Red Lists.

Altogether, 99 species were red-listed (CR-LC) in 2024, compared to 203 species in 2013 (Table 7). Not Evaluated (NE) for the Red List II refers to HELCOM HUB classes that were not possible to assess due to data limitations. The 2023 assessment was expert judgement driven.

Table 7. Distribution of the different IUCN Red List classifications in the current and previous Red List assessments.

	SUM	CR	EN	VU	NT	DD	LC	NE
2013 Red List	322	1	10	4	42	0	146	119
2024 Red List II	322	1	1	5	0	39	53	223

Of these, 173 are benthic habitat types at Level 6. Data provided by Contracting Parties covered 90 of these 173 Level 6 classifications, thereby 52% of all HUB defined biotopes were covered in the current assessment at least to at some level. Supplementing this with extrapolated data from HELCOM Biodiversity and the ICES databases increased the coverage to 128 Level 6 HUB classifications, or to 74% coverage (see Figure 14).

These HUB classes have been documented in the data may not have had sufficient coverage and albeit their acknowledgement in the data, it was not possible to carry out an assessment on these.

It is important to note that, for most habitats/biotopes, the threat assessment relies not on comprehensive, long-term monitoring data, but rather on the best available data to provide insights into the occurrence of various habitats within the Baltic Sea.

The *Zostera marina* and *Zostera noltii* (eelgrass) monitoring program is presented as an example of a relatively data-rich case, contrasting with the more typical situation of limited data availability. These *Zostera marina*-dominated biotopes (AA.H1B7, AA.I1B7, AA.M1B7, and AA.J1B7) with their greater data availability, coupled with expert consensus that these habitat types are under considerable pressure throughout the Baltic Sea, which leads to applying the SPIA methodology to identify the threat category based on IUCN criterion C1.

The Red List II 2024 assessment, incorporating valuable expert input, reveals a complex picture of the conservation status of Baltic Sea habitats and biotopes, as habitats are varying in rarity across the Baltic, being common in one place and rare in another. The varied nature of the Baltic Sea, of its salinity gradient lowering the further into the Baltic the sea water travels and the change of landscape from sandy to rocky shores. This elaboration on results helps to better understand the threats faced by these habitats and to guide the conservation efforts.

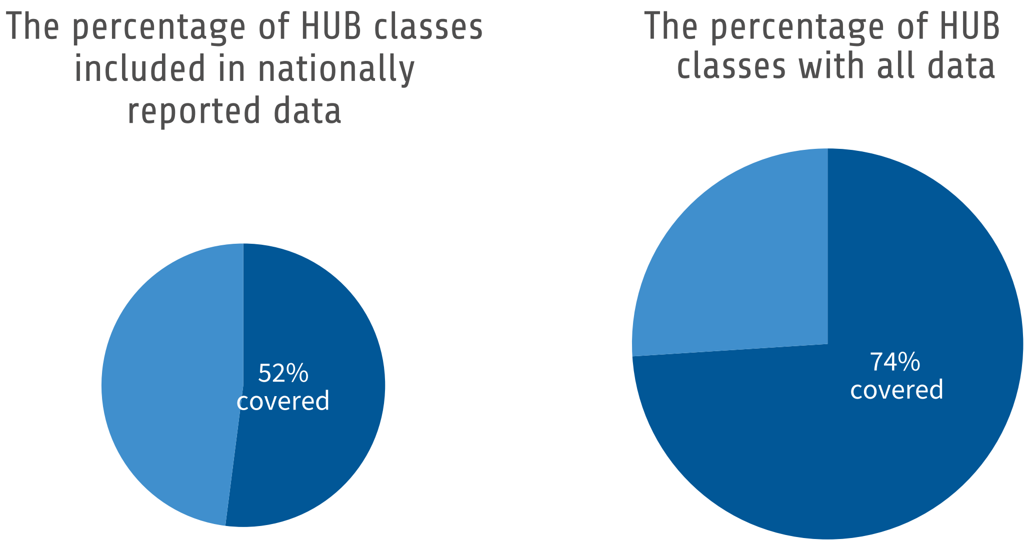

Figure 14. The percentage HELCOM HUB classes adressed in the data, before and after the addition of data sourced from public databases.

2.2.1 Assessment process

Available data and assessment methods

The Baltic Sea's diverse geological characteristics, from soft mud to bedrock, and its unique environmental gradients, including salinity, temperature, wave exposure, and light attenuation, create a complex continuum of biotic communities. A pronounced salinity gradient exists, with species numbers decreasing from around 1000 in the south to roughly 300 in the north (HELCOM 2012).

A strong halocline at 60-80 meters depth in the central Baltic creates anoxic conditions in deeper areas. Varying water turbidity limits light penetration, creating aphotic zones even in some shallower areas. Wave action, particularly in the extensive archipelagos, further shapes these underwater habitats. The varying nature of these aforementioned factors that shape the Baltic Sea environment further emphasizes the enigmatic properties of describing the benthic habitats.

Benthic habitat assessments have been made using different methods based on IUCN criteria B and C, for the different HELCOM HUB classes.

The HELCOM Red List II assessment process involved integrating data from various sources and methodologies. HELCOM Contracting Parties delivered data for the assessment in several formats: observation data, directly fitting the HELCOM HUB classification, modelled data structured according to HELCOM HUB (but generated using different extrapolating models), data reported using the EUNIS classification system and raw data on substrate and species coverage.

This diversity of data types and methodologies were harmonized, by translating EUNIS descriptions into HUB where possible, as well as aggregating raw data formats into relevant HUB results. These combined results were further merged and fit into European Environmental Agency's (EEA) 10x10 grid cells. This data set enabled an assessment applying the IUCN B2 criterion.

The HELCOM Red List II project initiated three data calls to gather information on Baltic Sea habitats, biotopes, and biotope complexes. The first (November 2022 - May 2023), integrated with the species data call, received data from only a few Contracting Parties (Estonia, Finland and Germany), which necessitated a second data call (July-October 2023) requesting raw observation data for red-listed habitats and biotopes to improve both assessments and the underlying HUB classification. A final third data call (July-October 2023) specifically targeted rare habitats and biotopes, requesting spatiotemporal distribution on a 1x1 km grid as a last attempt to improve overall data availability and accuracy to be used for assessments in the project.

Despite the contribution from Contracting Parties during the HELCOM Red List II project, data coverage was incomplete and did not fully support a data-driven assessment on a Baltic Sea scale (Figure 15).

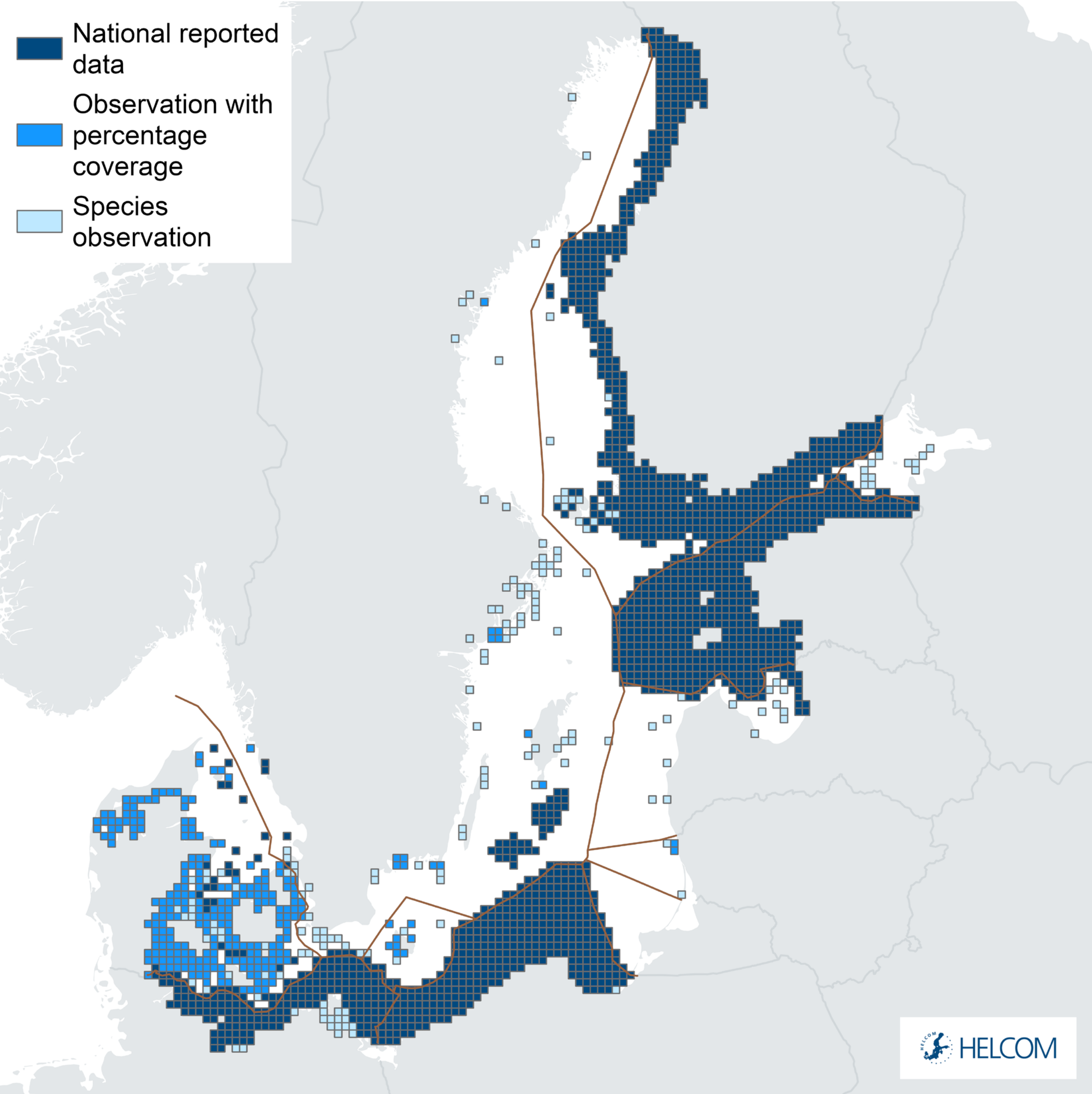

Figure 15. Coverage of biotope data made available for HELCOM Red List II assessment, indicating also Exclusive Economic Zones (EEZ) lines. The layering of data on the map is presented in hierarchal order, with higher confidence data (nationally reported data) as the top layer, followed by observation with percentage coverage (medium confidence) and lastly Species observation data layer in the bottom reflecting the low confidence.

For data reported to HELCOM on species observation for the HELCOM third Holistic Assessment, to be useful within the context of classifying the various benthic biotopes through the HUB classification system, information on percentage coverage of the species is required. This requirement drastically lowers available data fit for the analysis, as simple observations of single individual occurrences of a species are not enough to confidently say that habitat forming feature/species occur at a density where it would form the habitat/biotope. A collection of relevant species that define HUB classes at level 6 were gathered from different databases, namely the information relevant for the Baltic Sea assessment area in the DOME database managed by ICES and HELCOM Biodiversity database (see Figure 16).

EUSeaMap 2021		ICES-COMBINE- / HELCOM Biodiversity Database data		Together
AA.J	**+**	**1B7**	**=**	**AA.J1B7**

Figure 16. A visual representation of the intersection of EUSeaMap 2021 along with the HUB class equivalent to the defining species observation from the ICES–COMBINE and HELCOM Biodiversity Database.

Intersecting the species observation data with the EUSeaMap 2021 modelled substrate type and photic properties enabled more data points and locations on HUB classes to become available for the assessment.

The HELCOM HUB classification system defines biotopes based on the presence and abundance of characteristic species. Consequently, species restricted to a single HELCOM HUB habitat can serve as proxies for that habitat, as their presence and status reflect the defining features of the biotope. This assessment therefore assumes that the threat status of a species uniquely associated with a particular HELCOM HUB habitat provides a reasonable indication of the threat status of that corresponding habitat that they define. Disregarding the abiotic factors that also define the HELCOM HUB habitat, has been taken into consideration and evaluated based on the substrate type's likelihood of occurrence when considering the species. The translated results are therefore an extrapolation of the species' threat category in this report.

The limitation faced by the methodology used to gather data for this assessment. The data collected did not provide comprehensive coverage of the entire Baltic Sea, and the representation of rare benthic habitats within existing monitoring programs is insufficient and would probably require specific data collection efforts perhaps through ad hoc projects or efforts rather than regular environmental monitoring programmes. The accuracy of habitat type classification was also limited, particularly due to the difference in scale between the broad-scale modeled substrate data (EUSeaMap 2021) and the finer-scale point observations of species occurrences. While expert input was used to validate habitat coverage estimates, this approach has its own limitations. The project was designed with a data-driven approach, and the inability to use data, due to data scarcity, and be fully data-driven was a core principle, although as mentioned the expert elicitation helped increase data coverage and confidence of the results. Furthermore, the use of species as proxies for certain rare habitat types focuses solely on the threat status of the species, not on the substrate, precluding a direct assessment of substrate-related threats.

Despite these limitations, the Red List II 2024 assessment, informed by both data analysis and expert judgement, offers synthesized information of what is currently available for understanding the conservation status of Baltic Sea habitats. The assessment underscores the dynamic nature of these ecosystems and highlights the critical need for continued monitoring, research, and conservation actions to protect biodiversity and ecological functions. The challenges encountered in this assessment, particularly regarding data scarcity and methodological limitations, provide valuable insights for improving future Red List evaluations and conservation strategies in the Baltic Sea.

2.2.2 Benthic habitat specific results

Baltic aphotic muddy sediment dominated by *Haploops spp.* **(AB.H1I2)** has been reclassified from Endangered in 2013 to Critically Endangered (CR) in 2024, indicating a significant decline in the health of this habitat. Furthermore, the Baltic aphotic muddy sediment dominated by sea pens **(AB.H2T1)** has retained the Endangered classification from its status from 2013. The results of these threat categories are derived from the species-specific threat, where the status of *Haploops spp.* has deteriorated from the previous Red List 2013 assessment from Endangered (EN) to the Red List II assessment Critically Endangered (CR).

Applying IUCN criterion B2 to the available data identified 53 habitats as Least Concern (LC) (see Annex 1), these include for example Baltic photic muddy sediment dominated by sedges (Cyperaceae) (**AA.H1A2**), Baltic photic muddy sediment dominated by Charales (**AA.H1B4**) and Baltic photic muddy sediment dominated by common eelgrass (*Zostera marina*) (**AA.H1B7**) (see Figure 17).

These aforementioned habitats were Near Threatened (NT) in the 2013 HELCOM Red List assessment which was expert judgement driven. Multiple experts engaged in the Red List II project nominated by the Contracting Parties expressed concern that the assigned Least Concern (LC) threat categories for **AA.H1B4** and **AA.H1B7** may underestimate their actual vulnerability.

To address this concern further analysis, as it is common practice for Red List assessments. To assess the biotope with as many IUCN criteria as possible was possible for the Zostera dominated biotopes as the data was sufficient to apply IUCN criterion C1. This supplementary analysis, however, confirmed the original Least Concern (LC) classification (see Table 8).

The Vulnerable (VU) category, based on assessments applying IUCN criteria B2ii, encompasses habitats facing significant threats that could lead to their decline. Expert opinion was used in determining whether data limitations reflected true habitat extent or data deficiency.

Despite the overall data discrepancy multiple HELCOM HUB habitats have been assessed based on the material available. Most habitats fall under the Data Deficient (DD) or Not Evaluated (NE) category, highlighting the lack of available information to accurately assess their threat status. This includes Baltic aphotic muddy sediment dominated by ocean quahog (*Arctica islandica*) (**AB.H3L3**) which was categorized as Endangered (EN) during the 2013 HELCOM Red List assessment, Baltic photic muddy sediment dominated by spiny naiad (**AA.H1B5**) or unattached *Fucus spp.* (**AA.H1Q1**) and Baltic photic coarse sediment dominated by Charales (**AA.I1B4**) which both was categorized as Near Threatened (NT) during the 2013 RLE.

The HELCOM HUB biotopes classified as Not Evaluated (NE), have been classified so, either due to diverging expert opinions, lack of consensus on their threat level or data availability in their entirety. Among these are Baltic aphotic hard clay dominated, and Baltic aphotic muddy sediment dominated by Astarte spp. (**AB.B1E4** and **AB.H3L5** respectively) and HELCOM HUB biotopes dominated by unattached *Fucus spp.* (dwarf form) (**AA.M1Q2**, **AA.J1Q2**, **AA.I1Q2** and **AA.H1Q2**). The biotopes dominated by *Fucus spp.* (dwarf form) are difficult to acquire data for, as the biotope is dominated by a very specific growth-form of *Fucus spp.* and specific monitoring efforts are needed to correctly identify this species. These difficulties are with high likelihood the cause of the data deficiency reflected in the results. Furthermore, these HELCOM HUB classified biotopes were all assessed Endangered (EN) during the expert judgement driven 2013 RLE using B2c and A1 criterion. This highlights the problematic relationship between the difficulty of acquiring data for an otherwise threatened and rare habitat on the one hand, and the replicability of expert judgement-based assessments when the same experts may not be available when an assessment is repeated a decade later.

Table 8. Relative severity and Spatial extent results from the IUCN criterion C1 analysis using SPIA tool with the threat category assigned. Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Threat category Red List II 2024	HELCOM HUB habitat code	Spatial Extent	Relative severity	Threat category Red List 2013
LC	**AA.H1B7**	18.7	28.3	**NT**
VU	**AA.I1B7**	21.2	30.9	**NT**
VU	**AA.J1B7**	19.8	33.7	**NT**
VU	**AA.M1B7**	26.9	32.8	**NT**

The Baltic photic muddy sediment dominated by common eelgrass (*Zostera marina*) – AA.H1B7

This habitat was categorized as Near Threatened (NT) in the 2013 HELCOM Red List assessment as expert judgement driven. In 2024 Red List II **AA.H1B7** (Figure 17) was assigned Least Concern (LC) threat.

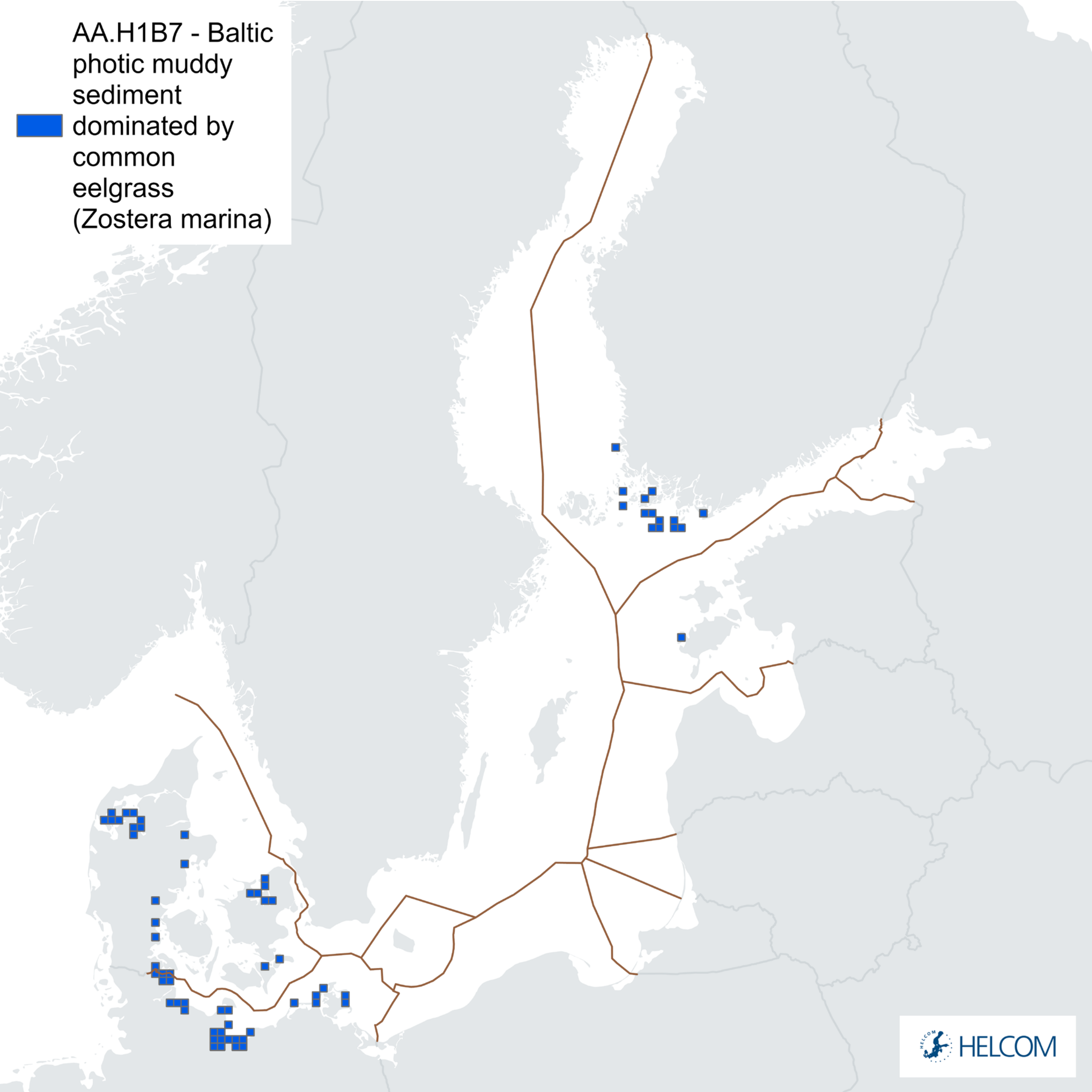

Figure 17. The Baltic photic muddy sediment dominated by common eelgrass (*Zostera marina*) – AA.H1B7 data fitted into the standardized 10x10km EEA grid cells along with the Baltic sea's EEZ.

Baltic photic coarse sediment dominated by common eel-grass (*Zostera marina*) – AA.I1B7

Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*) (see Figure 18) was changed from Near Threatened (NT) in 2013 to Vulnerable (VU) in the current assessment, indicating a deteriorating status. Expert input supports this assessment, emphasizing the increasing pressures on this habitat and the need for proactive conservation measures to protect these *Zostera marina* beds.

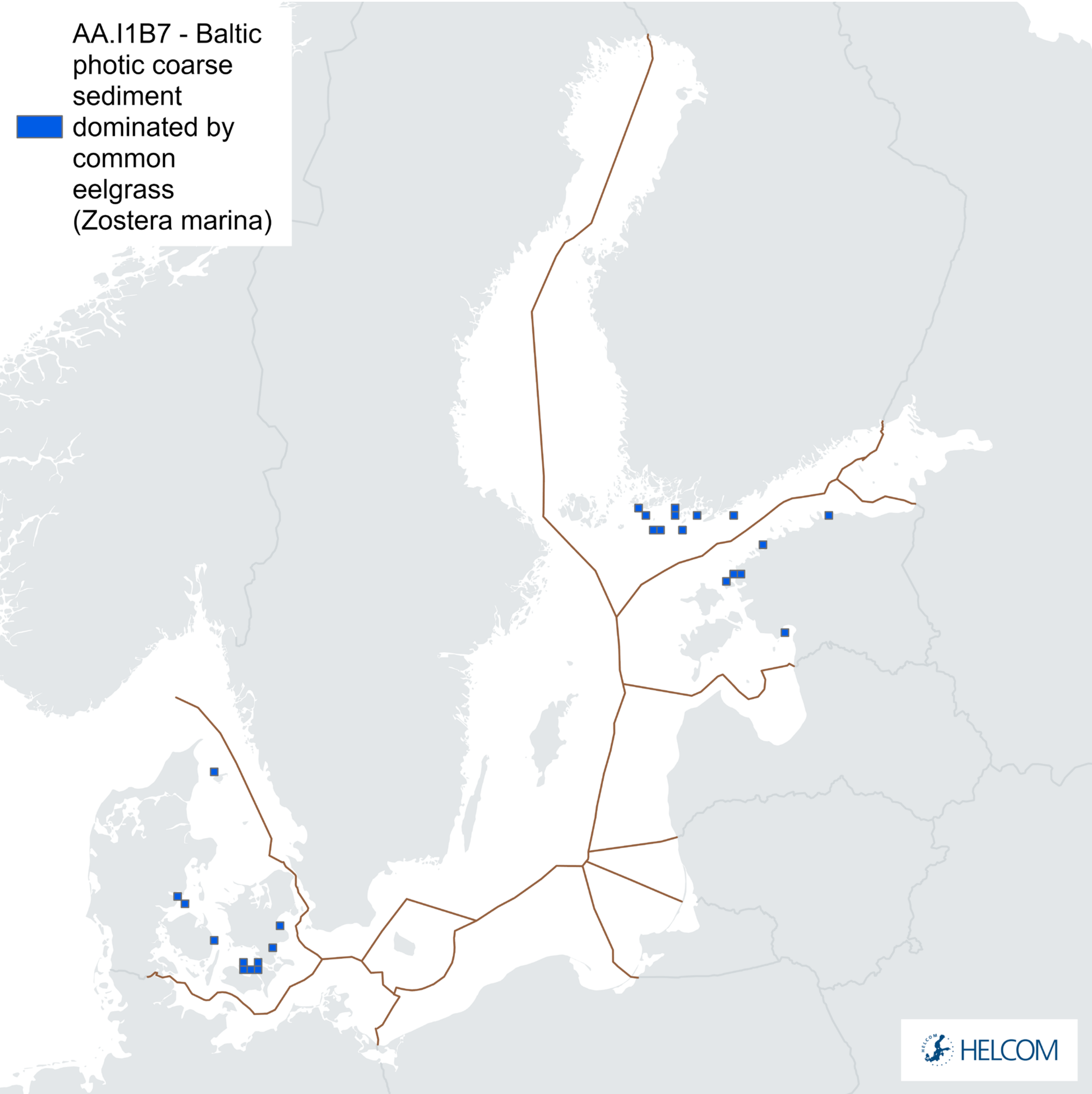

Figure 18. The Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*) – AA.I1B7 data fitted into the standardized 10x10km EEA grid cells along with the Baltic sea's EEZ.

The Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*) – AA.M1B7

The Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*) (see Figure 19) was assessed using both IUCN criteria B2 and C1, resulting in threat categories of Least Concern (LC) and Vulnerable (VU), respectively (see Table 9). While the B2 assessment suggests a lower level of threat, the VU classification under criterion C1, compared to the Near Threatened (NT) category in the 2013 Red List, indicates ongoing and potentially increasing exposure to threats from human activities (e.g. eutrophication and dredging) for this habitat.

Table 9. The four HUB classes on *Zostera marina*, namely AA.I1B7, AA.M1B7 and AA.J1B7 and AA.H1B7 that were assessed using both IUCN criterion B2ii and criterion C1, showcasing assessment results for each criteria.

HUB class ID	Description of habitat type	IUCN criteria B2	IUCN criteria C1
AA.H1B7	Baltic photic muddy sediment dominated by common eelgrass (*Zostera marina*)	LC	LC
AA.I1B7	Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*)	VU	VU
AA.M1B7	Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*)	LC	VU
AA.J1B7	Baltic photic sand dominated by common eelgrass (*Zostera marina*)	LC	VU

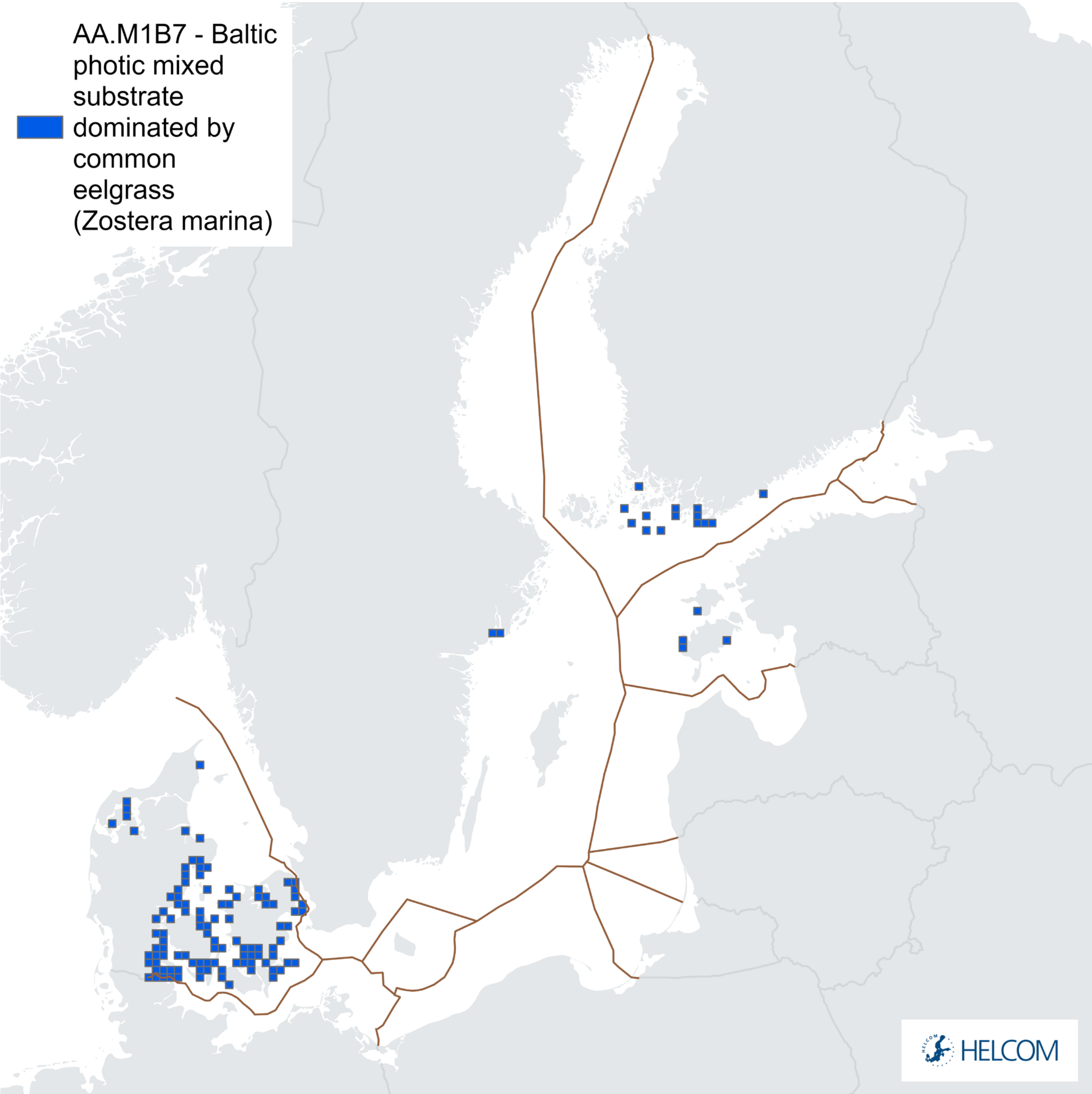

Figure 19. The Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*) – AA.M1B7 data fitted into the standardized 10x10km EEA grid cells along with the Baltic sea's EEZ.

The Baltic photic sand dominated by common eelgrass (*Zostera marina*) – AA.J1B7

The Baltic photic sand dominated by common eelgrass *(Zostera marina)* (see Figure 20) was also assessed using both IUCN criteria B2 and C1, resulting in threat categories of Least Concern (LC) and Vulnerable (VU), respectively (see Table 9). Like the mixed substrate eelgrass habitat (**AA.M1B7**), the VU classification under criterion C1, compared to the Near Threatened (NT) category in the 2013 Red List, indicates ongoing and potentially increasing vulnerability for this sandy bottom *Zostera marina* habitat.

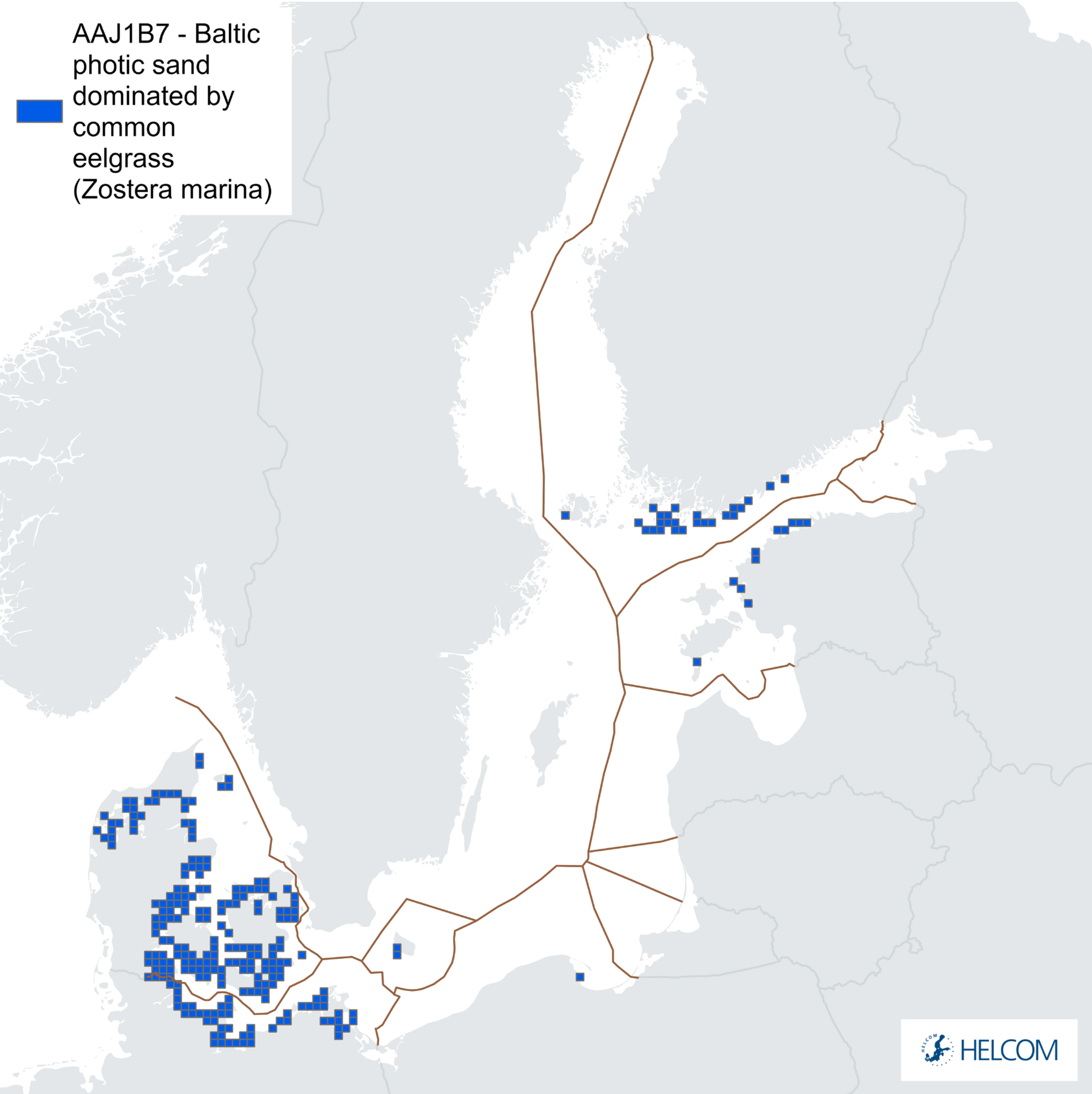

Figure 20. The Baltic photic sand dominated by common eelgrass (*Zostera marina*) – AA.J1B7 data fitted into the standardized 10x10km EEA grid cells along with the Baltic sea's EEZ.

Baltic photic sand dominated by ocean quahog (*Arctica islandica*) –AA.J3L3

Another habitat classified as Vulnerable (VU) under IUCN criteria B2 is the Baltic photic sand dominated by ocean quahog (*Arctica islandica*) (see Figure 21). Similar to the eelgrass beds, this biotope has also shifted from Near Threatened in 2013 to Vulnerable in 2024. This change highlights the growing threats to this habitat and underscores the importance of implementing conservation actions to safeguard the *Arctica islandica* populations and the sandy bottom ecosystem they inhabit. *Arctica islandica* is furthermore also found in aphotic sand, which did not have enough coverage to be assessed, but should be considered to be under similar pressures as AA.J3L3, and with that also suggestively reflect the threat category of VU.

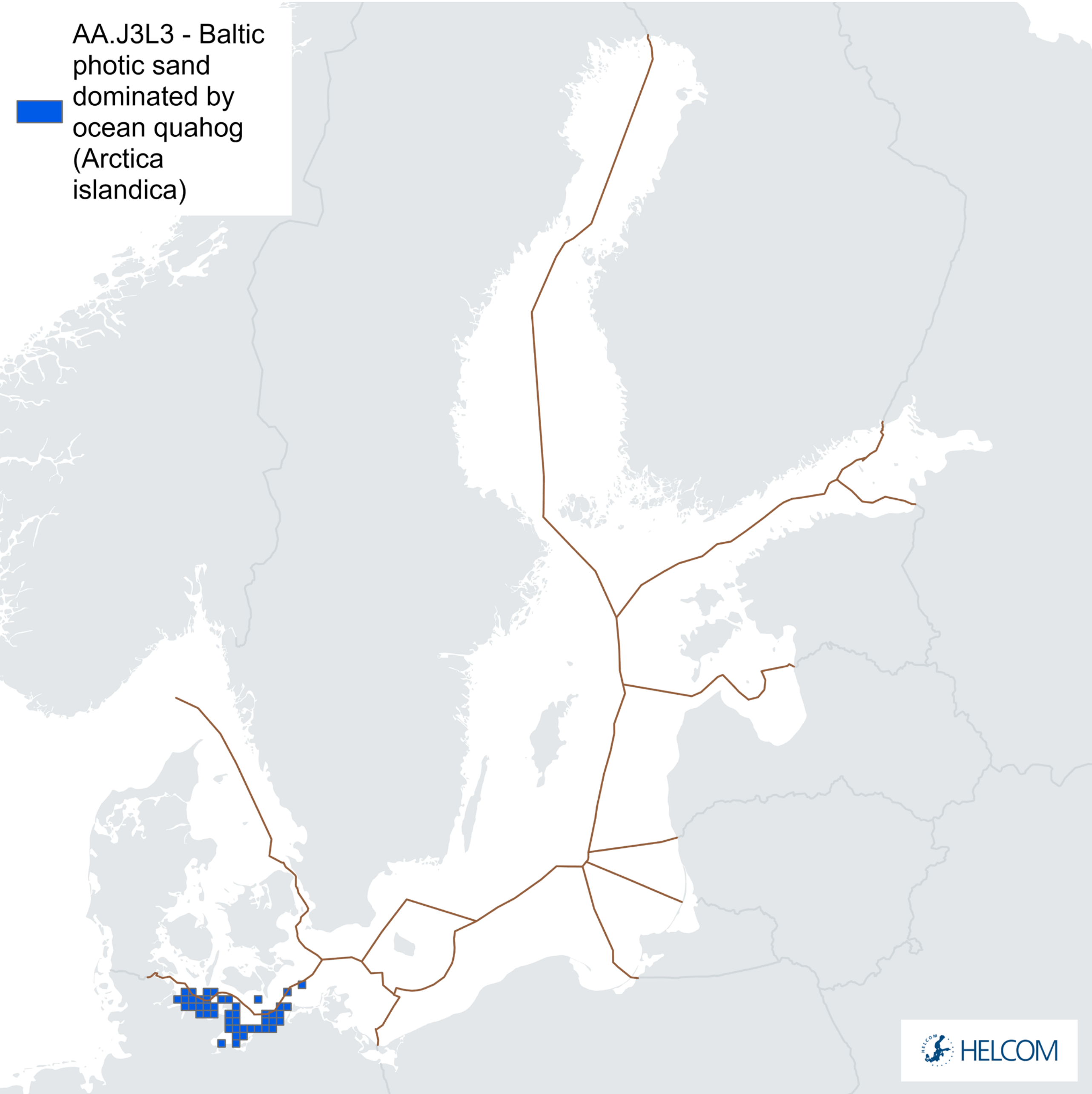

Figure 21. Occurrence of Baltic photic sand dominated by ocean quahog (*Arctica islandica*) – AA.J3L3 data fitted into the standardized 10x10km EEA grid cells along with the Baltic sea's EEZ.

2.3. Pelagic habitat assessment

Pelagic habitats have been excluded from direct assessment in the Red List II project. The primary reason for this exclusion is that the pelagic habitats definition is based on oxic and anoxic properties, which was now considered to be more suited to describe the quality of a habitat rather than defining it. An update of the HELCOM HUB classification of habitats was considered appropriate, but outside the scope of the Red List II project, to complete before a threat assessment would be carried out (Table 10). The total list of pelagic habitats is also available in Annex 2 of this report.

The Red List II assessment was carried out only for the Baltic Sea seasonal ice evaluating it as Endangered (EN) compared to the previous categorization Vulnerable (VU) made in 2013 Red List assessment.

The concerns for Baltic Sea seasonal ice are based on the most important factor being air temperature, but also wind, snow cover and ocean currents. Over the past 100 years, the winters have become milder, the ice season shorter and the maximum ice extent decreased (HELCOM climate change factsheet 2021). This is why the Baltic Sea seasonal ice threat category is EN.

Table 10. Pelagic habitat threat categories.

Red List II 2024	Criteria 2024	HUB code	HUB name	Red List 2013	Criteria 2013
EN	A1, A2a	AC	Baltic Sea seasonal Ice	VU	A1, A2a
NE		AE.O5	Baltic Sea aphotic pelagic below halocline oxic	EN	A3
NE		AD.N5	Baltic Sea Photic Pelagic above halocline oxic	LC	A1
NE		AE.N5	Baltic Sea Aphotic Pelagic above halocline oxic	LC	A1
NE		AE.N6	Baltic Sea Aphotic Pelagic above halocline anoxic	LC	A1
NE		AE.O6	Baltic Sea Aphotic Pelagic below halocline anoxic	LC	A1

3. Past, current and future threats

Reducing pressures and ensuring conservation are of key importance for ensuring the benthic habitats' biodiversity and integrity. Benthic habitats are impacted by several pressures from human activities occurring at the same time, including pollution and alterations of the physical habitat (Villnäs *et al.* 2013, Sundblad *et al.* 2014). Moreover, as the main part of the seafloor is covered by soft sediments, the macrozoobenthic community is a key component to be considered in any evaluation of the status of the environment. In addition to providing vital ecosystem functions, benthic habitats and their associated species and communities also provide valuable ecosystem services, including carbon and nutrient assimilation, storage, and sequestration nursery areas for fish (See chapter on ecosystem services in the HOLAS 3 Economic and Social Analyses (HELCOM 2023b).

Human activities exert a range of pressures on Baltic Sea benthic habitats, impacting their integrity and function (Figure 22). As described in the methodology for assessing biotope complexes (Table 11) and *Zostera marina* habitats, these pressures are quantified using the HELCOM Spatial distribution of Pressures and Impacts Assessment (SPIA) tool, primarily relying on data from the HOLAS 3 assessment (2016-2021). However, to align with the 50-year timeframe required by IUCN Criterion C, the pressures observed during this six-year period are assumed to be representative of longer-term trends, especially in the case of sub-criteria C1 and C2B.

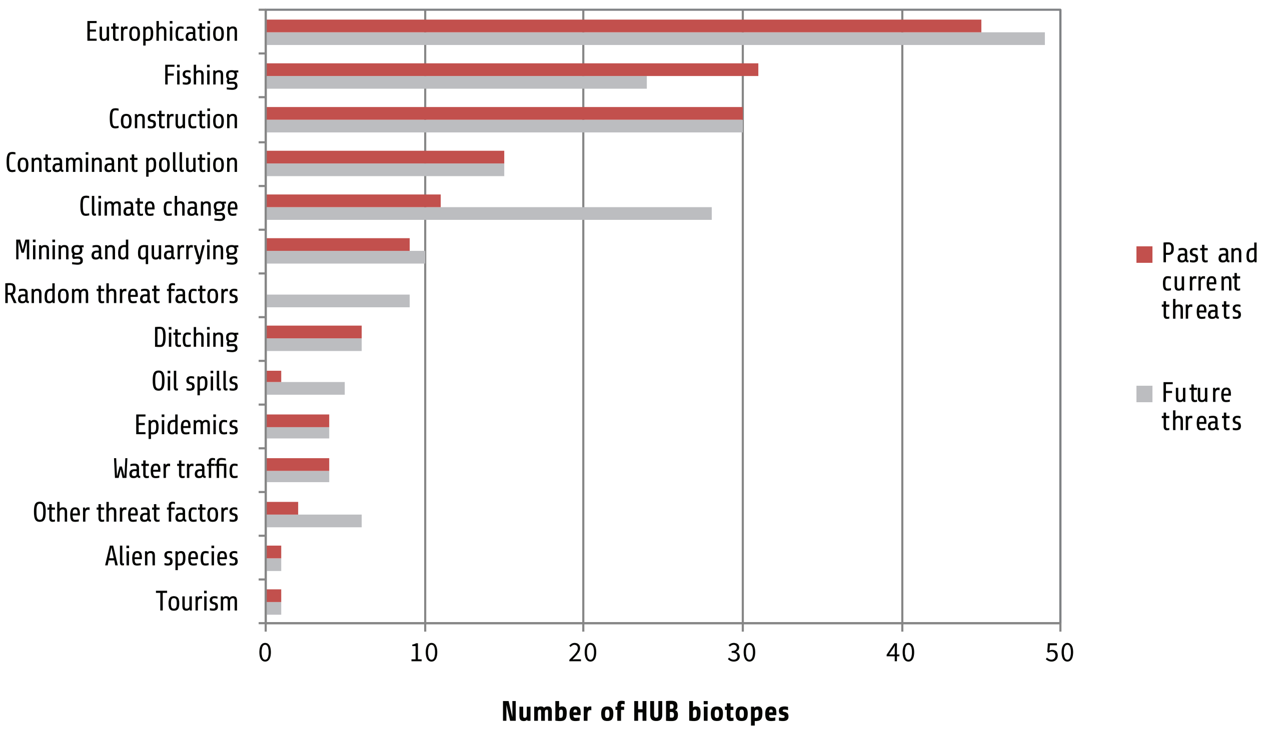

Figure 22. Past and current threats (reasons for becoming threatened) for the red-listed HELCOM HUB biotopes and future threats, counted for habitats by the HELCOM Red List experts in 2013 and in 2024.

A common thread of anthropogenic stressors, including habitat alteration, various forms of pollution (especially eutrophication and contaminant pollution), unsustainable resource extraction, and the pervasive effects of coastal and offshore development, weaves through the threats faced by these diverse coastal and marine biotope complexes. Recognizing the interconnectedness of these threats and implementing comprehensive management strategies are crucial to safeguarding the future of these valuable ecosystems.

Physical pressures, stemming from various human activities, significantly impact Baltic Sea benthic habitats (HELCOM, 2023b). These pressures include physical loss, resulting from activities like coastal construction and infrastructure development, which permanently remove or smother seabed habitats. Physical damage, caused by bottom trawling (Figure 23), dredging, and anchoring, disrupts the seafloor, damaging or killing benthic organisms and altering sediment structure (HELCOM, 2023b). The severity of the impact depends on the intensity and frequency of the disturbance, as well as the sensitivity of the affected habitat. Repeated disturbance can lead to long-term changes in community composition, reducing biodiversity and impairing ecosystem function. The HELCOM (2023b) assessment highlights that while some areas show signs of recovery following reductions in certain physical pressures (e.g., decreased trawling intensity in some regions), the cumulative and long-lasting effects of these pressures, particularly on sensitive and slow-growing species and habitats, remain a concern. Addressing these pressures requires spatial management measures, such as marine protected areas, and the adoption of less destructive fishing and dredging practices. Managing physical disturbances is crucial to maintaining the structural integrity and ecological function of Baltic Sea benthic ecosystems.

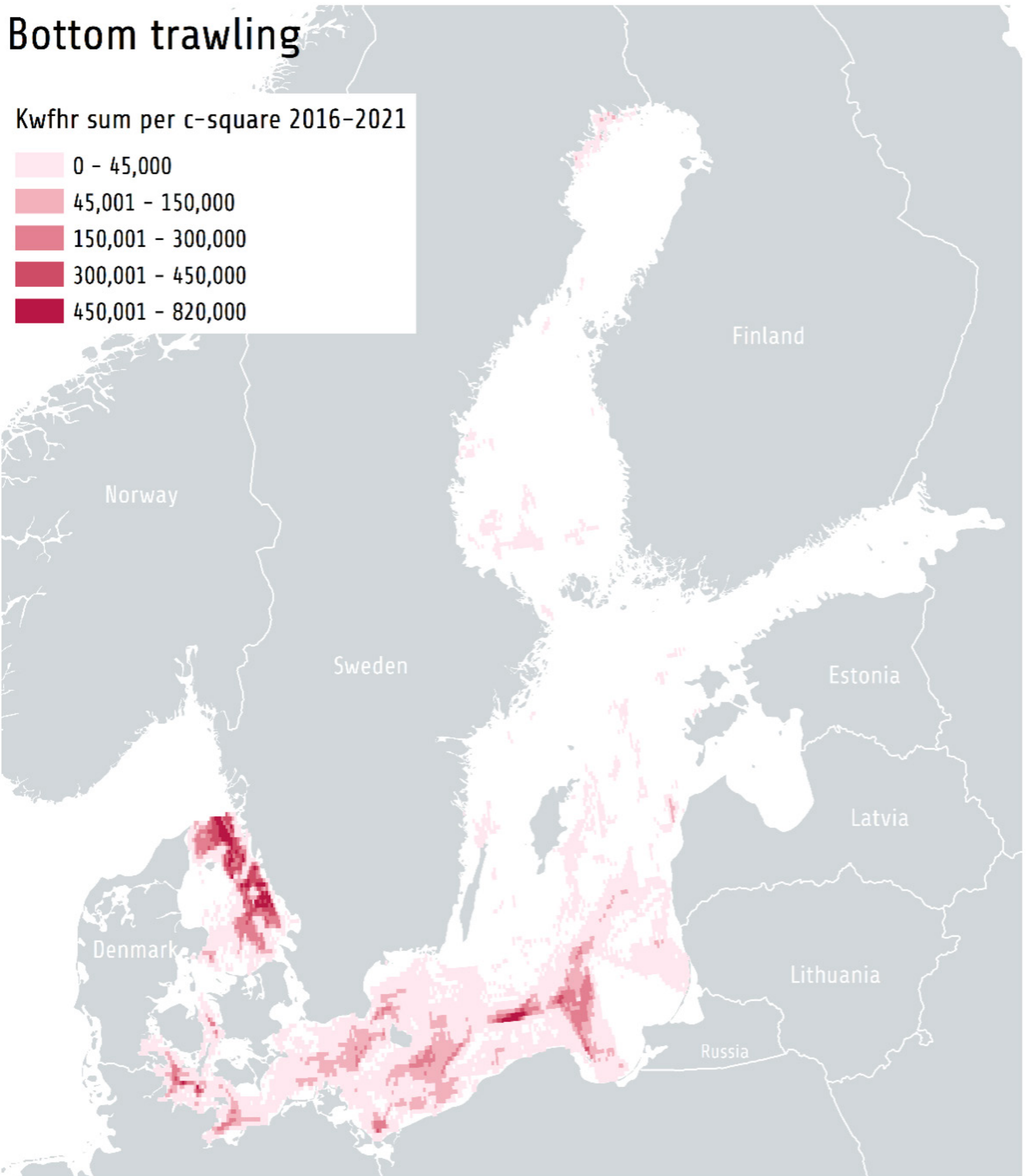

Figure 23. Spatial distribution and intensity of bottom trawling in the Baltic Sea 2016–2021.

Several human activities cause **physical disturbance** to the seafloor, negatively impacting benthic biotopes. These include for example bottom trawling, mariculture, sediment extraction and disposal, construction, coastal protection measures, and shipping. These activities directly damage habitats and alter their physical structure. A disturbance can vary in magnitude to the benthic habitat, being complete loss of the defining features caused by dredging or trawling. The effects of these can furthermore also change the landscape to a point where it changes character and changes defining features and become a different biotope in its entirety.

Dredging activities are usually divided into capital dredging and maintenance dredging. Capital dredging is carried out when building new constructions, increasing the depth in existing waterways, or making new waterways, while maintenance dredging is done in order to maintain existing waterways (see Figure 24). Dredging causes different types of pressure on the seabed – removal of substrate alters physical conditions through changes in the seabed topography, increased turbidity caused by re-suspended fine sediments, and smothering and siltation of nearby areas due to settling of suspended load. Physical loss occurs during capital dredging and may also be connected to maintenance dredging when performed repeatedly at regular intervals. The physical loss is limited to the dredging site, whilst physical disturbance through sedimentation may have a wider spatial extent (HELCOM 2023a).

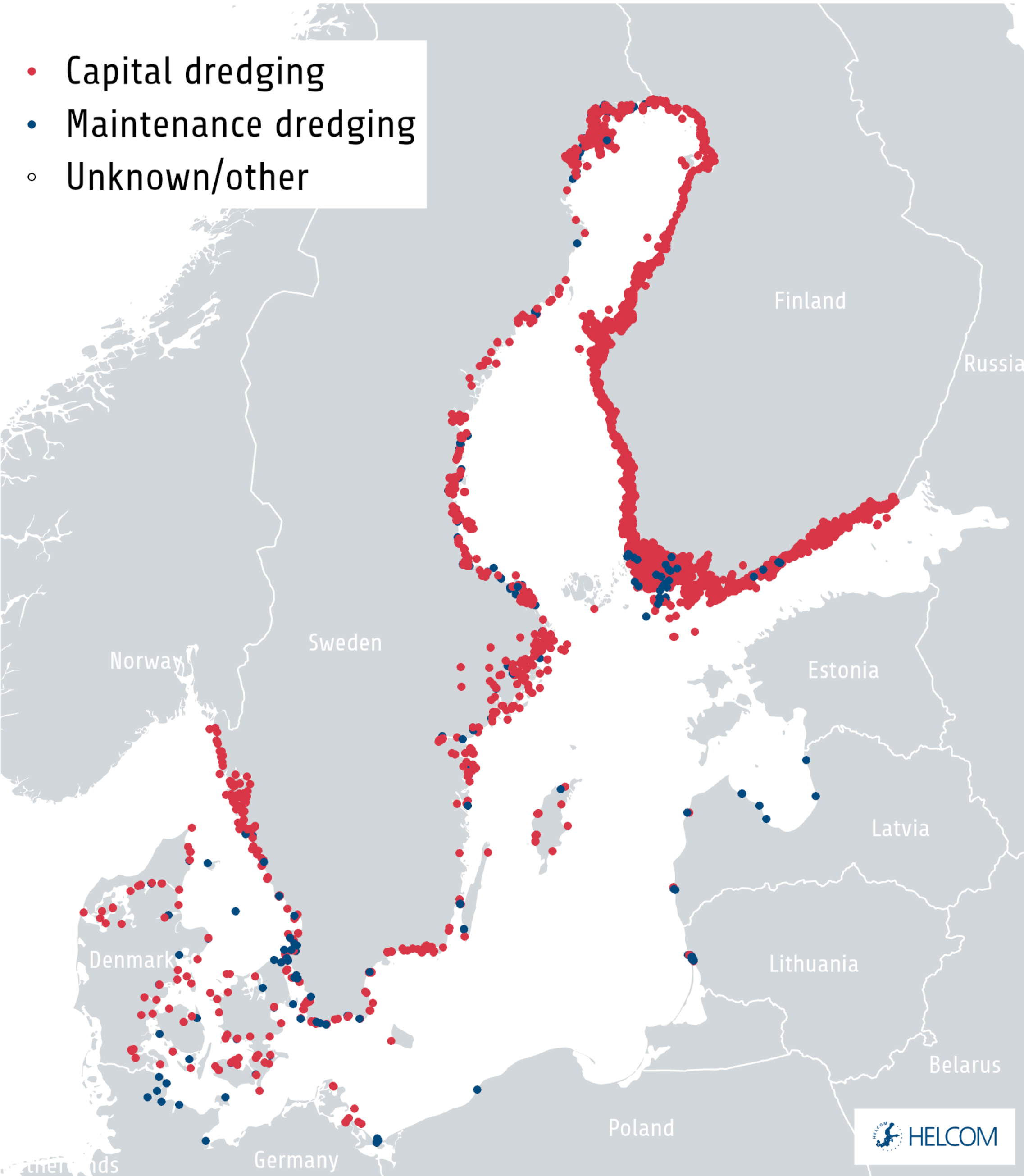

Figure 24. Maintenance, capital and unknown dredging operations in the Baltic Sea in 2016–2021.

Table 11. The biotope complexes with their corresponding threats influencing them negatively (expert validated). Note that Sandbanks, Reefs and Boreal Baltic Narrow Inlets have been excluded from the Red List II assessment process.

Biotope complexes	Past, current and future threats
Estuaries (1130)	• Physical alteration of the geological formations or the flow regime of the water (such as upstream hydro-dynamics, residual buildings and harbors) • Eutrophication and pollution impacting the macrofauna community • Maritime traffic • Alien species
Mudflats and sandflats (1140)	• Contaminant pollution and oil spills • Construction around the coastal lagoon disrupts local wildlife • Unsustainable fishing methods • Dredging, both small-scale and large-scale projects • Eutrophication and pollution impacting macrofauna community
Coastal lagoons (1150)	• Incidental oil spills • Construction around the coastal lagoon disrupts local wildlife • Unsustainable fishing methods, mussel dredging • Dredging, both small-scale and large-scale projects • Eutrophication and contaminant pollution impacting macrofauna community
large shallow inlets and bays (1160)	• Tourism • Mussel dredging and aquaculture • Dredging, dumping of dredged material • Coastal- and marine construction • Contaminant pollution • Eutrophication and pollution impacting macrofauna community
Submarine structures made by leaking gases (1180)	• Fishery, bottom trawling, anchoring • Eutrophication and contaminating pollutants impacting macrofauna community • Maritime traffic • Offshore construction • Alien species
Baltic esker islands (1610)	• Dredging of shallow shores threatens • Recreational activities • Construction activities • Eutrophication and pollution impacting macrofauna community

Table 11. (Continued) The biotope complexes with their corresponding threats influencing them negatively (expert validated). Note that Sandbanks, Reefs and Boreal Baltic Narrow Inlets have been excluded from the Red List II assessment process.

Biotope complexes	Past, current and future threats
Boreal Baltic islets and small islands (1620)	• Incidental oil-spills • Offshore construction affecting hydrodynamics (offshore windfarms specifically), • Dredging and dumping of dredged material • Tourism • Eutrophication and pollution impacting macrofauna community
Boreal Baltic narrow inlets (1650)	• Construction e.g. bridges. • Dredging and dumping of dredged material • Eutrophication and contaminating pollutants impacting macrofauna community
Sandbanks (1110)	• Sand and gravel extraction, • Offshore construction affecting hydrodynamics (offshore windfarms specifically mentioned), • Dredging and dumping of dredged material • Bottom trawling • Eutrophication and pollution impacting macrofauna community • Mussel dredging
Reefs (1170)	• Stone extraction (mining and quarrying), • Fishing and tangled fishing equipment poses a threat to reefs as fish are often abundant around reefs • Dredging and dumping of dredged material • Contaminant pollution • Eutrophication and pollution impacting macrofauna community

Another of the dominant pressures is **eutrophication**, driven by excessive inputs of nitrogen and phosphorus (HELCOM 2023d). Nutrient over-enrichment leads to changes in algal communities, increased turbidity, and oxygen depletion, all of which severely impact benthic ecosystems. While waterborne nutrient inputs have decreased since the 1980s (see Figure 25), the legacy effects of past nutrient loading, combined with ongoing inputs, continue to exert significant pressure on benthic communities. For photic biotopes, the resulting reduction in water transparency directly limits macrophyte growth, a foundational component of these ecosystems.

Hazardous substances, including heavy metals, Persistent organic pollutants (POPs), pharmaceuticals, and microplastics, pose a significant threat to Baltic Sea ecosystems, particularly benthic habitats (HELCOM, 2023a). Benthic organisms are exposed through direct contact with contaminated sediments, ingestion of pollutants, and absorption from the water column. This exposure leads to toxicity, bioaccumulation and biomagnification, endocrine disruption, and altered community structure. While some legacy pollutants have declined, many hazardous substances remain at concerning levels, and new contaminants continue to emerge (HELCOM, 2023a). The combined effects of multiple stressors, and long-term consequences of hazardous substance mixtures are a concern (HELCOM, 2023a). Addressing these threats requires reducing input, monitoring, and mitigating existing contamination.

Seafloor litter presents another significant pressure. Litter, particularly plastics, can cause anoxia in underlying sediments, altering biogeochemistry and benthic community structure (Goldberg, 1994). While some litter (e.g., glass, metal) can provide substrate for sessile organisms, potentially increasing local diversity (Mordecai *et al.*, 2011; Moret-Ferguson *et al.*, 2010; Pace *et al.,* 2007), this represents an unnatural alteration of community composition (Bergmann & Klages, 2012). Heavy plastics can sink and persist for centuries (Derraik, 2002), potentially impacting organisms through ingestion (Thompson, 2006; Ye & Andrady, 1991). Litter can also act as a source of hazardous substances, contributing to pollution. Monitoring seafloor litter is therefore crucial for a comprehensive understanding of marine pollution. The long-term persistence of many of these pressures reinforces the validity of extending the six-year HOLAS 3 timeframe to represent the broader 50-year period required by the IUCN criteria.

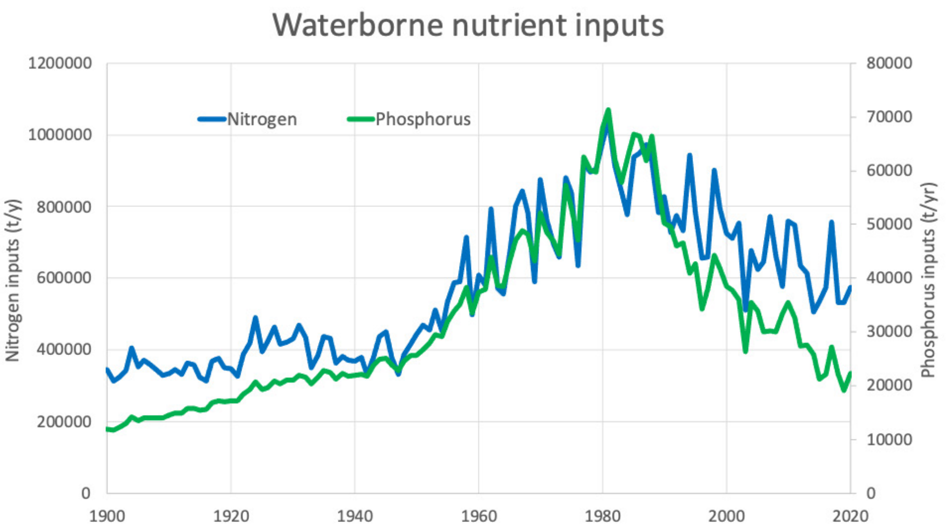

Figure 25. Nitrogen and Phosphorus concentrations in tons per year input into the Baltic Sea in the 1900–2021 period. (HELCOM 2023d).

4. Implementation reporting for HELCOM Recommendation 40/1 Conservation efforts done to habitats and biotope complexes since Red List 2013

The Helsinki Convention is a legally binding instrument to protect the Baltic Sea marine environment and enables the Helsinki Commission (HELCOM) to adopt soft-law Recommendations that set out specific actions and measures to be implemented by the Contracting Parties.

In 2019 the HELCOM Recommendation 40/1 on conservation and protection of marine and coastal biotopes, habitats and biotope complexes categorized as threatened according to the HELCOM Red Lists was adopted (HELCOM Recommendation 40/1). The aim of the Recommendation is to protect threatened marine and coastal biotopes, habitats, and biotope complexes in the Baltic Sea. This includes updating national legislation, regulating damaging activities, and implementing conservation and recovery plans.

The Recommendation draws attention to the alarming situation of many marine biotopes, particularly those classified as Critically Endangered, Endangered, or Vulnerable in the 2013 HELCOM Red List, and notes that the status of some has deteriorated over the past 15-20 years.

The first implementation reporting of Recommendation 40/1 was conducted from October 2020 until June 2021. This resulted in an inventory of existing and planned national and regional conservation-, recovery- and/or action plans as well as other relevant programmes and measures for the protection of biotopes, habitats and biotope complexes which are threatened according to the 2013 HELCOM Red List.

The 2013 HELCOM Red List project listed 25 biotopes, habitats and biotope complexes as threatened (CR, EN, VU), compared to the 15 biotopes, habitats and biotope complexes in the Red List II assessment in 2024 (Table 12).

The following sections provide an overview of the implementation reporting from Contracting Parties against the 2013 Red List results of biotopes, habitats and biotope complexes then assessed as threatened and provides examples of what actions and measures have since been implemented by Contracting Parties.

The section finally provides observations on cases where the 2024 Red List II assessment identified new biotopes, habitats and biotope complexes that may require new types of interventions. The information is intended as a simple review of Recommendation 40/1 as a basis for possible future discussions on any need for review of the Recommendation. A summary is presented in the conclusion section.

Table 12. Threatened red-listed biotopes, habitats and biotope complexes in 2013 and 2024.

RED LIST:	2013	2024	2013	2024	2013	2024
	CR	CR	EN	EN	VU	VU
Biotope complexes	1	0	2	5	5	2
Benthic habitats	1	1	10	1	4	5
Pelagic habitats	0	0	1	1	1	0
TOTAL:	**2**	**1**	**13**	**7**	**10**	**7**

4.1. Biotope complexes; Recommendation 40/1 implementation overview

For the majority of the 2013 Red List threatened species (categories CR-VU) some Contracting Parties have measures and plans in place, some do not. Only the submarine structures made by leaking gases (1180) has measures in place by both of the Contracting Parties where the biotope complex is present but despite these efforts has remained in Endangered category (Table 13).

Three biotope complexes (Coastal lagoons (Endangered), Submarine structures made by leaking gases (Endangered) and Large shallow inlets and bays (Vulnerable)) have remained in the 2013 threat category.

Estuaries have been moved from Critically Endangered to a lower Endangered threat category in 2024, despite the fact that not all the Contracting Parties where the biotope complex is present have national measures in place.

Table 13. Biotope complexes implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a biotope complex of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Treatened biotope complexes	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
1130	Estuaries	CR	Present. Spatial management plan.	Present. Spatial management plan.	Present. General conservation measures.	Present. No plan in place.	??	??	Present. No plan in place.	Present. Spatial management plan.	EN
1150	Coastal lagoons	EN	Present. Spatial management plan.	Present. Spatial management plan.	Present. Other legal measures.	Present. Other leagal measures.	??	??	Present. No plan in place.	Present. Spatial management plan.	EN
1180	Submarine structures made by leaking gases	EN	Present. Spatial management plan.	Not present	Not present	Not present	??	??	Not present	Present. Spatial management plan.	EN
1160	Large shallow inlets and bays	VU	Present. Spatial management plan.	Present. Spatial management plan.	Present. Plan under consideration.	Present. No plan in place.	??	??	Present. No plan in place.	Present. Spatial management plan.	VU

Table 13. (Continued). Biotope complexes implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a biotope complex of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Treatened biotope complexes	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
1140	Mudflats and sandflats not covered by seawater at low tide	**VU**	Present. Spatial management plan.	Present. Spatial management plan.	Not present	Present. No plan in place.	??	??	Not present	Present. Spatial management plan.	**EN**
1110	Sandbanks slightly covered by sea water all the time	**VU**	Present. Spatial management plan.	Present. Spatial management plan.	Present. Plan under considera-tion.	Present. Spatial management plan and other legal measures.	??	??	Present. No plan in place.	Present. Spatial management plan.	**NE**
1170	Reefs	**VU**	Present. Spatial management plan.	Present. Spatial management plan.	Present. No man-agement plan.	Present. Spatial management plan and other legal measures.	??	??	Present. No man-agement plan.	Present. Spatial management plan.	**NE**
1650	Boreal Baltic narrow inlets	**VU**	Not present	Not present	Present. Plan under considera-tion.	Not present	??	??	Not present	Present. Spatial management plan.	**NE**
1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation*	**NT**									**EN**
1620	Boreal Baltic islets and small is-lands*	**NT**									**VU**

The 2024 HELCOM Red List II assessment highlighted some needs for future management action:

— Coastal lagoons, Submarine structures made by leaking gases and Large shallow inlets and bays have remained in the previous threat category and are in need of revision of currently existing national measures to protect the complexes from getting into a worse threat category.
— For submarine structures made by leaking gases there might be a need to put in place joint regional measures to keep the biotope complex becoming collapsed.
— Sandbanks (1110), reefs (1170) and boreal Baltic narrow inlets (1650), all categorized as Vulnerable in 2013 Red List, were not evaluated in the Red List II assessment due to the lack of available data, meaning their status in currently unknown. These biotope complexes are in need of additional background data to be categorized properly during the next red-listing.
— Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation (1610) was categorized as Near Threatened in 2013, and thereby did not require implementation reporting against Recommendation 40/1 (see Table 13) but was assessed as being in the Endangered threat category in 2024. Boreal Baltic islets and small islands (1620) was also Near Threatened in 2013 but moved to Vulnerable threat category in 2024. The Red List II assessment indicates thus that it could be relevant to also include those biotope complexes categorized as Near Threatened in the Recommendation implementation reporting list, since the status can change rapidly to a threatened category in only a few years.
— The overall recommendation is to have national measures in place for all threatened biotope complexes and if necessary, consider also joint regional measures.
— A '??' marking in the implementation reporting column indicates that no information was received during the implementation reporting round.

4.2. Benthic habitats; Recommendation 40/1 implementation overview

The benthic habitat implementation overview shows that four Contracting Parties have not reported according to the Recommendation 40/1 (Table 14) and two Contracting Parties have reported that none of the threatened benthic habitats are present in their marine waters. This leads to a conclusion that the threatened benthic habitats have only spatial management plans in place by one Contracting Party where they are present, and no other measures are in place for the Baltic Sea benthic habitats or are currently unknown due to non-reporting.

Table 14. Benthic habitat implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a benthic habitat of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Threatened benthic habitats	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
AB.H3L3	Baltic aphotic muddy sediment dominated by ocean quahog (*Arctica islandica*)	CR	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	DD
AB.H1I2	Baltic aphotic muddy sediment dominated by *Haploops* spp.	EN	??	??	Not present	Not present	??	Not present	??	Present. Spatial management plan.	CR
AB.H2T1	Baltic aphotic muddy sediment dominated by seapens	EN	??	??	Not present	Not present	??	Not present	??	Present. Spatial management plan.	EN
AB.H3L5	Baltic aphotic muddy sediment dominated by *Astarte* spp.	EN	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	DD
AA.D	Baltic photic maerl beds	EN	??	??	Not present	Not present	??	Not present	??	Present. Spatial management plan.	NE
AA.H1Q2	Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	EN	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	NE

Table 14. (Continued). Benthic habitat implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a benthic habitat of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Threatened benthic habitats	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
AA.I1Q2	Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (dwarf form)	**EN**	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	**NE**
AA.J1Q2	Baltic photic sand dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	**EN**	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	**NE**
AA.M1Q2	Baltic photic mixed substrate dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	**EN**	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	**NE**
AB.B1E4	Baltic aphotic hard clay dominated by *Astarte* spp.	**EN**	??	??	Not present	Not present	??	Not present	??	Not present	**NE**
AB.D	Baltic aphotic maerl beds	**EN**	??	??	Not present	Not present	??	Not present	??	Present. Spatial management plan.	**NE**
AB.J3L3	Baltic aphotic sand dominated by ocean quahog (*Arctica islandica*)	**VU**	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	**DD**

Table 14. (Continued). Benthic habitat implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a benthic habitat of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Threatened benthic habitats	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
AA.E1F1	Baltic photic shell gravel dominated by vase tunicate (*Ciona intestinalis*)	**VU**	??	??	Not present	Present. No plan in place.	??	Not present	??	Not present	**NE**
AA.G	Baltic photic peat bottom	**VU**	??	??	Not present	Present. No plan in place.	??	Not present	??	Not present	**NE**
AB.E1F1	Baltic aphotic shell gravel dominated by vase tunicate (*Ciona intestinalis*)	**VU**	??	??	Not present	Present. No plan in place.	??	Not present	??	Present. Spatial management plan.	**NE**
AA.J3L3	Baltic photic sand dominated by ocean quahog (Arctica islandica)*	**NT**									**VU**
AA.I1B7	Baltic photic coarse sediment dominated by common eelgrass (Zostera marina)*	**NT**									**VU**
AA.M1B7	Baltic photic mixed substrate dominated by common eelgrass (Zostera marina)*	**NT**									**VU**
AA.J1B7	Baltic photic sand dominated by common eelgrass (Zostera marina)*	**NT**									**VU**

The 2024 HELCOM Red List II assessment highlighted some needs for future management action:

— 13 habitats out of the 15 threatened habitats from 2013 Red List were categorized either Data Deficient or Not Evaluated due to the lack of available data for the Red List II assessment process, meaning we are not currently able to categorize them according to the IUCN criteria and thus not knowing their current status in the Baltic Sea.
— Baltic aphotic muddy sediment dominated by *Haploops spp.* (AB.H1I2) was moved up from the Endangered category into Critically Endangered in 2024 and is still in need of additional background data.
— Baltic aphotic muddy sediment dominated by seapens (AB.H2T1) remained in the 2013 Endangered category and is also in need of additional background data for the next red-listing assessment process.
— 4 benthic habitats previously categorized as Near Threatened have been moved into a Vulnerable threat category in 2024, indicating that there is a need to keep that category also on the implementation overview list.
— Overall recommendation is to have protection measures in place for all threatened habitats.

4.3. Pelagic habitats; Recommendation 40/1 implementation overview

2013 Red List categorized Baltic Sea aphotic pelagic below halocline oxic (AE.O5) as Endangered, having spatial management plan in place by only one Contracting Party (Table 15). Four Contracting Parties have not reported according to Recommendation 40/1, two say the pelagic habitat is not present and one indicates that it is not evaluated in their marine waters.

Baltic Sea seasonal ice was categorized as Vulnerable in 2013, having a plan or measures in place by two Contracting Parties. 4 Contracting Parties have not reported, one does not have it present, and one has indicated that it is not evaluated in their marine waters.

Table 15. Pelagic habitat implementation overview and 2024 Red List II categories assigned.
* a threat category assigned in 2024 (previously not threatened) and/or a pelagic habitat of interest to keep on of the Recommendation implementation overview. ?? indicates that there is no information provided by the Contracting Party. Light green color indicates a plan is in place (either targeted conservation measures or some other additional conservation- or legal measures). Light orange color indicates that the species is present, but no plan is in place.

HUB code	Threatened pelagic habitats	Red List 2013	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden	Red List II 2024
AE.O5	Baltic Sea aphotic pelagic below halocline oxic	EN	??	??	Not present	Not present	??	Not evaluated	??	Present. Spatial management plan.	NE
AC	Baltic Sea seasonal ice	VU	??	??	Present. General conservation measures.	Not present	??	Not evaluated	??	Present. Spatial management plan.	EN

The 2024 HELCOM Red List II assessment highlighted some needs for future management action:

— Baltic Sea aphotic pelagic below halocline oxic pelagic habitat was Not Evaluated in 2024 due to the lack of data, thus leaving the status of the habitat currently unknown.
— Baltic Sea seasonal ice has been moved into higher, Endangered, threat category in 2024.
— The HELCOM HUB classification of pelagic habitats is in need of an update during the next years.

4.4. Recommendation 40/1 review conclusions based on the implementation overview

Based on the Recommendation 40/1 implementation reporting on available national conservation measures, biotopes, habitats and biotope complexes can be divided into three groups based on the reported plans and measures in place:

— those threatened biotopes, habitats and biotope complexes for which no measures are in place / no information is available (Table 16)
— those threatened biotopes, habitats and biotope complexes for which some measures have been taken by some of the Contracting Parties (Table 17) and
— those threatened biotopes, habitats and biotope complexes for which measures are in place in all Contracting Parties where the species occurs (Table 18).

Table 16. Threatened biotopes, habitats and biotope complexes for which no measures are in place / no information is available.

Red List 2023		HUB code	No measures in place / no information available	Red List II 2024
EN	Benthic habitat	AB.B1E4	Baltic aphotic hard clay dominated by *Astarte* spp.	NE
VU	Benthic habitat	AA.E1F1	Baltic photic shell gravel dominated by vase tunicate (*Ciona intestinalis*)	NE
VU	Benthic habitat	AA.G	Baltic photic peat bottom	NE

Table 17. Threatened biotopes, habitats and biotope complexes for which some measures have been taken by some of the Contracting Parties.

Red List 2023		HUB code	Some measures in place	Red List II 2024
CR	Biotope complexes	1130	Estuaries	EN
EN	Biotope complexes	1150	Coastal lagoons	EN
VU	Biotope complexes	1160	Large shallow inlets and bays	VU
VU	Biotope complexes	1140	Mudflats and sandflats not covered by seawater at low tide	EN
VU	Biotope complexes	1110	Sandbanks slightly covered by sea water all the time	NE
VU	Biotope complexes	1170	Reefs	NE
VU	Biotope complexes	1650	Boreal Baltic narrow inlets	NE
CR	Benthic habitat	AB.H3L3	Baltic aphotic muddy sediment dominated by ocean quahog (*Arctica islandica*)	DD
EN	Benthic habitat	AB.H1I2	Baltic aphotic muddy sediment dominated by *Haploops* spp.	CR
EN	Benthic habitat	AB.H2T1	Baltic aphotic muddy sediment dominated by seapens	EN
EN	Benthic habitat	AB.H3L5	Baltic aphotic muddy sediment dominated by *Astarte* spp.	DD
EN	Benthic habitat	AA.D	Baltic photic maerl beds	NE
EN	Benthic habitat	AA.H1Q2	Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	NE
EN	Benthic habitat	AA.I1Q2	Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (dwarf form)	NE
EN	Benthic habitat	AA.J1Q2	Baltic photic sand dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	NE
EN	Benthic habitat	AA.M1Q2	Baltic photic mixed substrate dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)	NE
EN	Benthic habitat	AB.D	Baltic aphotic maerl beds	NE
VU	Benthic habitat	AB.J3L3	Baltic aphotic sand dominated by ocean quahog (*Arctica islandica*)	DD
VU	Benthic habitat	AB.E1F1	Baltic aphotic shell gravel dominated by vase tunicate (*Ciona intestinalis*)	NE
EN	Pelagic habitats	AE.O5	Baltic Sea aphotic pelagic below halocline oxic	NE
VU	Pelagic habitats	AC	Baltic Sea seasonal ice	EN

Table 18. Threatened biotopes, habitats and biotope complexes for which measures are in place in all Contracting Parties where the species occurs.

Red List 2023		HUB code	Measures in place	Red List II 2024
EN	Biotope complexes	1180	Submarine structures made by leaking gases	EN

While Contracting Parties have implemented measures to address biotope degradation, this review of the Recommendation 40/1 identified a further need to understand and classify the measures taken by the Contracting Parties. The aim is to have a coordinated approach for which level of measures (spatial measures, conservation measures, targeted measures, legal measures etc.) should be applied as a minimum requirement for protecting the status of red-listed threatened biotopes, habitats and biotope complexes (Table 19). It was not feasible in this review to compare reported information from Contracting Parties on a level of the concrete actions implemented for each biotope, habitat and biotope complex. To evaluate whether measures are sufficient, more information is needed than merely whether plans and measures are in place or not. There is also a need to identify those biotopes, habitats and biotope complexes that need regionally joint measures to reach the positive change in their threat categories.

According to the review, the biotope complexes show the best degree of implementation, likely due to their correspondence with Annex I habitats under the EU Habitats Directive. However, gaps remain in mapping, effectiveness reviews, MPA selection, and conservation measures.

Specific implementation gaps are apparent across different biotope categories such as Baltic Photic Benthos where implementation is generally poor.

Another deficiency is the lack of review process of the effectiveness of existing measures and the difficulty in assessing the effect of Contracting Parties' implementation status. This would inform an evaluation of further measures, or intensified implementation of existing measures, that need to be taken.

The current Recommendation 40/1 implementation overview list consists of those biotopes, habitats and biotope complexes that were categorized as threatened (Critically Endangered (CR), Endangered (EN) and Vulnerable (VU)) according to the 2013 Red List results. The 2024 Red List II has also identified that there could also be a need to add those biotopes, habitats and biotope complexes that have been categorized as Near Threatened to the reporting implementation list. When comparing the 2013 Red List categories to 2024 Red List II categories it shows changes for many biotopes, habitats and biotope complexes categorization from Near Threaten into threaten categories. It thereby seems like Near Threatened biotopes, habitats and biotope complexes would already be in need of protective action in order to prevent further deterioration.

There is also a need to call on those Contracting Parties that find '??' marking in their implementation reporting column to contribute information to the next implementation reporting round.

Strong emphasis is on the need for continuous periodical data collection especially for those biotopes, habitats and biotope complexes that are categorized as Data Deficient already since the 2013 Red List and for those that have been categorized Data Deficient and Not Evaluated as a result of the Red List II process in 2024. Without data availability it is not possible to assess these biotopes, habitats and biotope complexes status in the Baltic Sea and necessary measures cannot be taken to protect them from becoming regionally collapsed.

Table 19. Recommendations to strengthen future protection.

Recommendation 40/1 implementation overview list and reporting template up-date	Crucial data collection by Contracting Parties	Conservation measures implementation	Joint regional measures
Add to the implementation overview list of the implementation reporting Near Threatened (NT) category species.	2024 Data Deficient and Not Evaluated biotopes, habitats and biotope complexes should be prioritized through monitoring programmes for collecting crucial background data for the (next) red listing process.	Agree on a minimum implementation level of conservation measures (spatial measures, conservation measures, targeted measures, legal measures etc.) to be implemented by each Contracting Party.	Despite the national measures in place, some biotopes, habitats and biotope complexes remain threatened. There is a possible need to have regionally coordinated plan/measures in place to protect them from becoming regionally collapsed.
Update current reporting template with selective drop-down answers to keep the comparable responses.	Many biotopes, habitats and biotope complexes that have been categorized by the red-listing process are still in need of additional background data collection.	A joint approach is needed for those biotopes, habitats and biotope complexes that are nationally not in a threatened category, however, are regionally assessed as threatened. Recommend which conservation actions are needed as a minimum for these biotopes, habitats and biotope complexes to be implemented by Contracting Parties.	Those biotopes, habitats and biotope complexes that are nationally Least Concern but are regionally threatened might need to have joint regional actions in place.
Add a field to the reporting template column for reporting biotopes, habitats and biotope complexes national red listing category (as an input to BIS sheets).	It is crucial to have regionally agreed joint definitions of what defines a habitat and based on which agreed classification scheme. This should inform monitoring and collection of data activities so that all the results are comparable.		Those biotopes, habitats and biotope complexes where no action plans/measures are in place might also need joint regional cooperation/measures.

5. Conclusions and proposals of the HELCOM Red List II project

Altogether, seven biotope complexes (compared to eight in 2013) are threatened and classified either as Endangered (five in 2024, two in 2013) or Vulnerable (two in 2024, five in 2013) (Table 20).

From the benthic and pelagic habitats eight (compared to 17 in 2013) are threatened and classified either as Critically Endangered (one in 2024, one in 2013), Endangered (two in 2024, 11 in 2013) or Vulnerable (five in 2024 and five in 2013) (Table 21).

There are a total of 322 biotopes and habitats listed in HELCOM HUB, 81.37% of them were not possible to assess against the IUCN criteria due to the lack of data: 39 of them were categorized as Data Deficient and 223 as Not Evaluated in Red List II assessment; and from the 10 biotope complexes 30% were unassessed: three were categorized as Not Evaluated. This means that a huge number of biotopes, habitats and biotope complexes are currently in an unknown status in the Baltic Sea.

The ambition, as expected since the previous HELCOM Red List project, to achieve good environmental status in the Baltic Sea by 2020 and complete the Baltic Sea Action Plan (BSAP) with detailed actions by 2021, has not been fully realized. This underscores the ongoing need for strengthened monitoring efforts and enhanced cooperation among HELCOM Contracting Parties to implement measures to protect Baltic Sea biodiversity.

Table 20. HELCOM Red List of Baltic Sea biotope complexes. Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Red List II 2024	Criteria 2024	HUB code	Biotope complexes	Red List 2013	Criteria 2013
EN	C1	1130	Estuaries	CR	C1
EN	B2c(ii)	1180	Submarine structures made by leaking gases	EN	B2c(ii)
EN		1150	Coastal lagoons	EN	C1
EN	C1	1140	Mudflats and sandflats not covered by seawater at low tide	VU	C1
EN	C1	1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	NT	C1
VU	C1	1160	Large shallow inlets and bays	VU	C1
VU		1620	Boreal Baltic islets and small islands	NT	C1

Table 21. HELCOM Red List of Baltic Sea biotopes and habitats. Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Red List II 2024	Criteria 2024	HUB code	HUB name	Red List 2013	Criteria 2013
CR	A2b	AB.H1I2	Baltic aphotic muddy sediment dominated by *Haploops spp.*	EN	A1
EN		AB.H2T1	Baltic aphotic muddy sediment dominated by seapens	EN	A1
EN	A1, A2a	AC	*Baltic Sea seasonal Ice*	VU	A1, A2a
VU	B2	AA.J3L3	Baltic photic sand dominated by ocean quahog (*Arctica islandica*)	NT	A1
VU	B2, C1	AA.I1B7	Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*)	NT	A1
VU	B2, C1	AA.M1B7	Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina*)	NT	A1
VU	B2, C1	AA.J1B7	Baltic photic sand dominated by common eelgrass (*Zostera marina*)	NT	A1
VU		AA.J1Q1	Baltic photic sand dominated by stable aggregations of unattached *Fucus spp.* (typical form)	LC	A1

The HELCOM Red List II assessment also demonstrates a transition from a primarily expert-opinion-based approach to a more data-driven assessment. The identified data paucity and data reporting issues that prevented a full assessment of all biotopes further highlights the importance of comprehensive and comparable data, in order to assess the Baltic Sea and to guide regional implementation of protective measures and actions.

As a conclusion of the HELCOM Recommendation 40/1 implementation reporting, there are three threatened benthic habitats from 2013 that do not have any conservation measures in place and 21 threatened biotopes, habitats and biotope complexes that have some measures implemented by some of the Contracting Parties and only one threatened biotope complex which has conservation measures in place but still remains in the same threat category. This indicated a need for a review among the Contracting Parties to clarify which level of measures (spatial measures, conservation measures, targeted measures, legal measures, regional measures etc.) have been implemented, list the concrete measures, and what can be done both regionally and nationally in near future to protect the threatened biotopes, habitats and biotope complexes even more from not becoming regionally collapsed.

It is crucial to remember that a biotope does not need to be red-listed to warrant conservation action. Furthermore, even biotopes that were not assigned to a threat category in this assessment may still be under significant pressure and at risk of deterioration. The absence of a threat category does not equate to an absence of risk, especially under the current conditions of severe data paucity issues influencing the coverage and confidence in the assessments. HELCOM applies the precautionary principle, meaning that measures should be taken also in the absence of complete data and information of the risk to any component of the ecosystem if there is a perceived risk or threat from human activities.

Future Red List updates, supported by increased data availability for HELCOM HUB defined biotopes, may allow for the application of the Collapsed (CO) category. Assigning the Collapsed category requires extensive mapping and detailed knowledge of historical biotope distributions. Currently, many HELCOM HUB biotopes are poorly documented, making Collapsed assessments difficult. It is also possible that some previously existing, but now absent, Baltic Sea biotopes are not included in HELCOM HUB due to insufficient documentation. A Collapsed assessment relies on the accuracy and ecological relevance of the underlying biotope classification. A HELCOM HUB biotope could be categorized as Collapsed if a significant, irreversible change in the coverage of its characteristic biotic element occurred. For instance, if a biotope defined by >10% coverage of a key species shifted to 5% coverage, and the >10% coverage biotope no longer existed in the Baltic Sea, the Collapsed category would be appropriate. The practical application of HELCOM HUB and ongoing monitoring will refine the understanding of these critical thresholds and improve the accuracy of future Collapsed assessments.

A recurring challenge throughout the Red List II assessment process, as in the 2013 project, has been the severe lack of long-term data on the characteristics of many Baltic Sea biotopes. Data is particularly important, and lacking, in areas outside the scope of HELCOM or dedicated national monitoring programs. While acknowledging the substantial costs associated with benthic monitoring, neglecting this monitoring carries significant risks for the biodiversity of the seafloor. Potential solutions include further development of high-resolution models of abiotic factors (e.g., substrate, bathymetry, light availability) through initiatives like EMODnet's EU Sea Map, to improve predictive capabilities, as well as harmonization of national modelling programs. However, observational data and species monitoring remain essential for validating models and ensuring the reliability of future reporting. The ultimate safeguarding of Baltic Sea biodiversity depends not only on improved monitoring and data, but also, crucially, on effective management actions to mitigate pressures and achieve Good Environmental Status. Without it, enhancing our knowledge of the benthic biological community, is negligible.

Some overall recommendations based on the HELCOM Red List II project for future include:

— There is a need for continuous monitoring of the benthic and pelagic habitats and biotope complexes to be able to see the changes in their status and threat categorization. Lack of monitoring is a general problem, resulting in lack of data for the assessment and status categorization process.
— Conservation measures and action plans must be set in place to protect the habitats and biotopes with a high risk of becoming regionally collapsed.
— Optimizing monitoring programs to encompass a wider range of parameters (e.g. species coverage and substrate type at location of observation), thereby enhancing the utility of datasets.
— A more systematic and harmonized approach to modeling data across the region would also improve the transnational assessment of shared Baltic habitat.
— Increased cooperation and data sharing among Contracting Parties.
— Open data call to Contracting Parties to provide historical data on relevant species to enhance temporal knowledge on a regional scale.
— Develop, or build upon existing, methodologies in early phases of a possible Red List III project in cooperation with Contracting Parties experts to enhance workflow and accuracy of the results.
— Redefine HELCOM pelagic HUB classes (e.g. the definition of different pelagic habitats should not reflect oxic and anoxic conditions) and continue the update of HUB.
— Bridge the gap between the HELCOM HUB classification system and other European classification systems (e.g. EUNIS) to ease and enhance the usability of data across platforms.
— If allowed by increased data availability, applying the Collapsed (CO) threat category, can enhance the and improve the accuracy of the future assessment for severely threatened biotopes and biotope complexes.

Annex 1 Benthic habitat threat categories

Download the Excel sheet (.XLSX) here.

Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Red List II 2024	Criteria 2024	HUB code	HUB name	Red List 2013	Criteria 2013
CR	A2b	AB.H1I2	Baltic aphotic muddy sediment dominated by Haploops spp.	EN	A1
EN	A2b	AB.H2T1	Baltic aphotic muddy sediment dominated by seapens	EN	A1
VU	B2	AA.J3L3	Baltic photic sand dominated by ocean quahog (Arctica islandica)	NT	A1
VU	B2, C1	AA.I1B7	Baltic photic coarse sediment dominated by common eelgrass (Zostera marina)	NT	A1
VU	B2, C1	AA.M1B7	Baltic photic mixed substrate dominated by common eelgrass (Zostera marina)	NT	A1
VU	B2, C1	AA.J1B7	Baltic photic sand dominated by common eelgrass (Zostera marina)	NT	A1
VU	B2	AA.J1Q1	Baltic photic sand dominated by stable aggregations of unattached Fucus spp. (typical form)	LC	A1
LC		AA.H1A2	Baltic photic muddy sediment dominated by sedges (Cyperaceae)	NT	A1
LC		AA.H1B4	Baltic photic muddy sediment dominated by Charales	NT	A1
LC	B2, C1	AA.H1B7	Baltic photic muddy sediment dominated by common eelgrass (Zostera marina)	NT	A1
LC		AB.H3O1	Baltic aphotic muddy sediment dominated by Amphiura filiformis	LC	A1
LC		AB.H3O2	Baltic aphotic muddy sediment dominated by Brissopsis lyrifera and Amphiura chiajei	LC	A1
LC		AB.H3M1	Baltic aphotic muddy sediment dominated by Scoloplos (Scoloplos) armiger	LC	A1
LC		AA.H1Q5	Baltic photic muddy sediment dominated by stable unattached aggregations of lake ball (Aegagropila linnaei)	LC	A1
LC		AA.H3L8	Baltic photic muddy sediment dominated by Abra spp.	LC	A1
LC		AA.J3L2	Baltic photic sand dominated by cockles (Cerastoderma spp)	LC	A1
LC		AA.J3M2	Baltic photic sand dominated by lugworms (Arenicola marina)	LC	A1
LC		AA.M1S1	Baltic photic mixed substrate dominated by filamentous annual algae	LC	A1
LC		AA.A1C1	Baltic photic rock and boulders dominated by Fucus spp.	LC	A1
LC		AA.A1C2	Baltic photic rock and boulders dominated by perennial non-filamentous corticated red algae	LC	A1
LC		AA.A1C5	Baltic photic rock and boulders dominated by perennial filamentous algae	LC	A1

LC	AA.A1E1	Baltic photic rock and boulders dominated by Mytilidae	LC	A1
LC	AA.A1H1	Baltic photic rock and boulders dominated by crustose moss animals (Electra crustulenta)	LC	A1
LC	AA.A1I1	Baltic photic rock and boulders dominated by barnacles (Balanidae)	LC	A1
LC	AA.H1A1	Baltic photic muddy sediment dominated by common reed (Phragmites australis)	LC	A1
LC	AA.H1B1	Baltic photic muddy sediment dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)	LC	A1
LC	AA.H1B2	Baltic photic muddy sediment dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii	LC	A1
LC	AA.H1B3	Baltic photic muddy sediment dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)	LC	A1
LC	AA.H1E1	Baltic photic muddy sediment dominated by Mytilidae	LC	A1
LC	AA.I1A1	Baltic photic coarse sediment dominated by common reed (Phragmites australis)	LC	A1
LC	AA.I1B1	Baltic photic coarse sediment dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)	LC	A1
LC	AA.I1B2	Baltic photic coarse sediment dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii	LC	A1
LC	AA.I1E1	Baltic photic coarse sediment dominated by Mytilidae	LC	A1
LC	AA.J1A1	Baltic photic sand dominated by common reed (Phragmites australis)	LC	A1
LC	AA.J1B1	Baltic photic sand dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)	LC	A1
LC	AA.J1B2	Baltic photic sand dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii	LC	A1
LC	AA.J1B3	Baltic photic sand dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)	LC	A1
LC	AA.J1E1	Baltic photic sand dominated by Mytilidae	LC	A1
LC	AA.J1Q3	Baltic photic sand dominated by stable aggregations of unattached Furcellaria lumbricalis	LC	A1
LC	AA.J3L1	Baltic photic sand dominated by Baltic tellin (Macoma balthica)	LC	A1
LC	AA.J3L4	Baltic photic sand dominated by sand gaper (Mya arenaria)	LC	A1
LC	AA.J3L9	Baltic photic sand dominated by multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica	LC	A1
LC	AA.M1A1	Baltic photic mixed substrate dominated by common reed (Phragmites australis)	LC	A1
LC	AA.M1B1	Baltic photic mixed substrate dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)	LC	A1

LC	AA.M1B2	Baltic photic mixed substrate dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii	LC	A1
LC	AA.M1B3	Baltic photic mixed substrate dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)	LC	A1
LC	AA.M1C1	Baltic photic mixed substrate dominated by Fucus spp.	LC	A1
LC	AA.M1C2	Baltic photic mixed substrate dominated by perennial non-fi lamentous corticated red algae	LC	A1
LC	AA.M1C5	Baltic photic mixed substrate dominated by perennial fi lamentous algae	LC	A1
LC	AA.M1E1	Baltic photic mixed substrate dominated by Mytilidae	LC	A1
LC	AA.M1Q3	Baltic photic mixed substrate dominated by stable aggregations of unattached Furcellaria lumbricalis	LC	A1
LC	AB.A1E1	Baltic aphotic rock and boulder dominated by Mytilidae	LC	A1
LC	AB.H3L1	Baltic aphotic muddy sediment dominated by Baltic tellin (Macoma baltica)	LC	A1
LC	AB.I1E1	Baltic aphotic coarse sediment dominated by Mytilidae	LC	A1
LC	AB.J1E1	Baltic aphotic sand dominated by unattached Mytilidae	LC	A1
LC	AB.J3L4	Baltic aphotic sand dominated by sand gaper (Mya arenaria)	LC	A1
LC	AB.M1E1	Baltic aphotic mixed substrate dominated by Mytilidae	LC	A1
LC	AB.M1I1	Baltic aphotic mixed substrate dominated by barnacles (Balanidae)	LC	A1
LC	AB.J3L9	Baltic aphotic sand dominated by multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica	NE	
LC	AB.J3L1	Baltic aphotic sand dominated by Baltic tellin (Macoma balthica)	NE	
DD	AB.H3L3	Baltic aphotic muddy sediment dominated by ocean quahog (Arctica islandica)	CR	A2
DD	AB.H3L5	Baltic aphotic muddy sediment dominated by Astarte spp.	EN	A1
DD	AB.J3L3	Baltic aphotic sand dominated by ocean quahog (Arctica islandica)	VU	A1
DD	AA.H1B5	Baltic photic muddy sediment dominated by spiny naiad (Najas marina)	NT	A1
DD	AA.I1B4	Baltic photic coarse sediment dominated by Charales	NT	A1
DD	AB.J3L7	Baltic aphotic sand dominated by striped venus (Chamelea gallina)	NT	A1
DD	AA.H3L6	Baltic photic muddy sediment dominated by Unionidae	NT	A1
DD	AA.H3L3	Baltic photic muddy sediment dominated by ocean quahog (Arctica islandica)	NT	A1
DD	AA.J1B4	Baltic photic sand dominated by Charales	NT	A1
DD	AA.J1B5	Baltic photic sand dominated by spiny naiad (Najas marina)	NT	A1
DD	AA.A1G1	Baltic photic rock and boulders dominated by hydroids (Hydrozoa)	LC	A1

DD		AA.H1B6	Baltic photic muddy sediment dominated by Ranunculus spp.	LC	A1
DD		AA.H1Q1	Baltic photic muddy sediment dominated by stable aggregations of unattached Fucus spp. (typical form)	LC	A1
DD		AA.H1Q3	Baltic photic muddy sediment dominated by stable aggregations of unattached Furcellaria lumbricalis	LC	A1
DD		AA.I1A2	Baltic photic coarse sediment dominated by sedges (Cyperaceae)	LC	A1
DD		AA.I1C1	Baltic photic coarse sediment dominated by Fucus spp.	LC	A1
DD		AA.I1C2	Baltic photic coarse sediment dominated by perennial non-fi lamentous corticated red algae	LC	A1
DD		AA.I1C3	Baltic photic coarse sediment dominated by perennial foliose red algae	LC	A1
DD		AA.I1C5	Baltic photic coarse sediment dominated by perennial fi lamentous algae	LC	A1
DD		AA.I1Q3	Baltic photic coarse sediment dominated by stable aggregations of unattached Furcellaria lumbricalis	LC	A1
DD		AA.J1S3	Baltic photic sand dominated by Vaucheria spp.	LC	A1
DD		AA.M1C3	Baltic photic mixed substrate dominated by foliose red algae	LC	A1
DD		AA.M1Q4	Baltic photic mixed substrate dominated by stable aggregations of unattached rigid hornwort (Ceratophyllum demersum)	LC	A1
DD		AB.A1G1	Baltic aphotic rock and boulders dominated by hydroids (Hydrozoa)	LC	A1
DD		AB.A1H1	Baltic aphotic rock and boulders dominated by corticated moss animals (Electra crustulenta)	LC	A1
DD		AB.A1I1	Baltic aphotic rock and boulders dominated by barnacles (Balanidae)	LC	A1
DD		AB.H1E1	Baltic aphotic muddy sediment dominated by Mytilidae	LC	A1
DD		AB.H4U2	Baltic aphotic muddy sediment dominated by anaerobic organisms	LC	A1
DD		AB.M1G1	Baltic aphotic mixed substrate dominated by hydroids (Hydrozoa)	LC	A1
DD		AB.M1H1	Baltic aphotic mixed substrate dominated by corticated moss animals (Electra crustulenta)	LC	A1
DD		AA.H1Q4	Baltic photic muddy sediment dominated by stable aggregations of unattached rigid hornwort (Ceratophyllum demersum)	LC	A1
DD		AA.H1S3	Baltic photic photic muddy sediment dominated by Vaucheria spp.	LC	A1
DD		AA.I1S2	Baltic photic coarse sediment dominated by Chorda fi lum and/or Halosiphon tomentosus	LC	A1
DD		AA.J1A2	Baltic photic sand dominated by sedges (Cyperaceae)	LC	A1
DD		AA.M1A2	Baltic photic mixed substrate dominated by sedges (Cyperaceae)	LC	A1
DD		AA.A1C3	Baltic photic rock and boulders dominated by perennial foliose red algae	LC	A1
DD		AA.I1B6	Baltic photic coarse sediment dominated by Ranunculus spp.	LC	A1
DD		AA.J1B6	Baltic photic sand dominated by Ranunculus spp.	LC	A1

DD	AA.H1E3	Baltic photic muddy sediment dominated by valve snails (Valvata spp.)	NE	
NE	AB.B1E4	Baltic aphotic hard clay dominated by Astarte spp.	EN	B2c(ii)
NE	AA.D	Baltic photic maërl beds	EN	B1+2a(ii)
NE	AB.D	Baltic aphotic maërl beds	EN	B1+2a(ii)
NE	AA.M1Q2	Baltic photic mixed substrate dominated by stable aggregations of unattached Fucus spp. (dwarf form)	EN	A1
NE	AA.J1Q2	Baltic photic sand dominated by stable aggregations of unattached Fucus spp. (dwarf form)	EN	A1
NE	AA.I1Q2	Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (dwarf form)	EN	A1
NE	AA.H1Q2	Baltic photic muddy sediment dominated by stable aggregations of unattached Fucus spp. (dwarf form)	EN	A1
NE	AA.G	Baltic photic peat bottoms	VU	B2b
NE	AB.E1F1	Baltic aphotic shell gravel dominated by vase tunicate (Ciona intestinalis)	VU	B1a(ii)
NE	AA.E1F1	Baltic photic shell gravel dominated by vase tunicate (Ciona intestinalis)	VU	B1a(ii)
NE	AA.A1H2	Baltic photic rock and boulders dominated by erect moss animals (Flustra foliacea)	NT	A1
NE	AA.E1C4	Baltic photic shell gravel dominated by kelp	NT	B1a(ii)
NE	AA.E3Y	Baltic photic shell gravel characterized by mixed infaunal macrocommunity in fi ne sand-like shell fragments	NT	B1a(ii)
NE	AB.M1J	Baltic aphotic mixed substrate characterized by epibenthic sponges (Porifera)	NT	A1
NE	AB.M1H2	Baltic aphotic mixed substrate dominated by erect moss animals (Flustra foliacea)	NT	A1
NE	AB.M1G2	Baltic aphotic mixed substrate dominated by sea anemones (Actiniarida)	NT	A1
NE	AB.M1G3	Baltic aphotic mixed substrate dominated stone corals (Scleractinida)	NT	A1
NE	AB.M1G4	Baltic aphotic mixed substrate dominated by soft corals (Alcyonacea)	NT	A1
NE	AB.M1F1	Baltic aphotic mixed substrate dominated by sea squirts (Ascidiacea)	NT	A1
NE	AB.J3L10	Baltic aphotic sand dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.	NT	A1
NE	AB.I3L10	Baltic aphotic coarse sediment dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.	NT	A1
NE	AB.I3L11	Baltic aphotic coarse sediment dominated by multiple infaunal polychaet-species including Ophelia spp.	NT	A1
NE	AB.H4U1	Baltic aphotic muddy sediment dominated by meiofauna	NT	A1
NE	AB.H3N1	Baltic aphotic muddy sediment dominated by Monoporeia affi nis and/or Pontoporeia femorata	NT	A1
NE	AB.E3Y	Baltic aphotic shell gravel characterized by mixed infaunal macrocommunity in fi ne sand-like shell fragments	NT	B1a(ii)
NE	AB.A1J	Baltic aphotic rock and boulders characterized by epibenthic sponges (Porifera)	NT	A1
NE	AB.A1H2	Baltic aphotic rock and boulders dominated by erect moss animals (Flustra foliacea)	NT	A1

NE	AB.A1G2	Baltic aphotic rock and boulders dominated by sea anemones (Actiniarida)	NT	A1
NE	AB.A1G3	Baltic aphotic rock and boulders dominated stone corals (Scleractinida)	NT	A1
NE	AB.A1G4	Baltic aphotic rock and boulders dominated by soft corals (Alcyonacea)	NT	A1
NE	AB.A1F1	Baltic aphotic rock and boulders dominated by sea squirts (Ascidiacea)	NT	A1
NE	AA.M1H2	Baltic photic mixed substrate dominated by erect moss animals (Flustra foliacea)	NT	A1
NE	AA.J3L10	Baltic photic sand dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.	NT	A1
NE	AA.J3L11	Baltic photic sand dominated by multiple infaunal polychaete species including Ophelia spp. and Travisia forbesii	NT	A1
NE	AA.I3L10	Baltic photic coarse sediment dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.	NT	
NE	AA.I3L11	Baltic photic coarse sediment dominated by multiple infaunal polychaete species including Ophelia spp.	NT	A1
NE	AB.J3L11	Baltic aphotic sand dominated by multiple infaunal polychaete species including Ophelia spp. and Travisia forbesii	NT	A1
NE	AA.M1B4	Baltic photic mixed substrate dominated by Charales	NT	A1
NE	AA.H3N2	Baltic photic muddy sediment dominated by mud shrimps (Corophiidae)	LC	A1
NE	AA.A1C4	Baltic photic rock and boulders dominated by kelp	LC	A1
NE	AA.A1D	Baltic photic rock and boulders characterized by aquatic moss	LC	A1
NE	AA.A1E2	Baltic photic rock and boulders dominated by zebra mussel (Dreissena polymorpha)	LC	A1
NE	AA.A1F1	Baltic photic rock and boulders dominated by sea squirts (Ascidiacea)	LC	A1
NE	AA.A1J	Baltic photic rock and boulders characterized by epibenthic sponges (Porifera)	LC	A1
NE	AA.A1R	Baltic photic rock and boulders characterized by soft crustose algae	LC	A1
NE	AA.A1S	Baltic photic rock and boulders characterized by annual algae	LC	A1
NE	AA.A1V	Baltic photic rock and boulders characterized by mixed epibenthic macrocommunity	LC	A1
NE	AA.A2	Baltic photic rock and boulders characterized by microphytobenthic organisms and grazing snails	LC	A1
NE	AA.A2T	Baltic photic rock and boulders characterized by sparse epibenthic macrocommunity	LC	A1
NE	AA.A4U	Baltic photic rock and boulders characterized by no macrocommunity	LC	A1
NE	AA.B1E1	Baltic photic hard clay dominated by Mytilidae	LC	A1
NE	AA.C	Baltic photic marl (marlstone rock)	LC	A1
NE	AA.E1E1	Baltic photic shell gravel dominated by Mytilidae	LC	A1
NE	AA.F	Baltic photic ferromanganese concretion bottom	LC	A1
NE	AA.H1B8	Baltic photic muddy sediment dominated by spikerush (Eleocharis spp.)	LC	A1

NE	AA.H1E2	Baltic photic muddy sediment dominated by zebra mussel (Dreissena polymorpha)	LC	A1
NE	AA.H1K1	Baltic photic muddy sediment dominated by tube building polychaetes	LC	A1
NE	AA.H3L1	Baltic photic muddy sediment dominated by Baltic tellin (Macoma balthica)	LC	A1
NE	AA.H3M3	Baltic photic muddy sediment dominated by Marenzelleria spp.	LC	A1
NE	AA.H3M6	Baltic photic muddy sediment dominated by various opportunistic polychaetes	LC	A1
NE	AA.H3N1	Baltic photic muddy sediment dominated by Monoporeia affinis	LC	A1
NE	AA.H3O	Baltic photic muddy sediment characterized by infaunal echinoderms	LC	A1
NE	AA.H3P1	Baltic photic muddy sediment dominated by midge larvae (Chironomidae)	LC	A1
NE	AA.H4U1	Baltic photic muddy sediment dominated by meiofauna (Oligochaeta, Ostracoda, Nematoda)	LC	A1
NE	AA.I1C4	Baltic photic coarse sediment dominated by kelp	LC	A1
NE	AA.I1D	Baltic photic coarse sediment characterized by aquatic moss	LC	A1
NE	AA.I1Q1	Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (typical form)	LC	A1
NE	AA.I2W	Baltic photic coarse sediment characterized by microphytobenthic organisms and grazing snails	LC	A1
NE	AA.I3N3	Baltic photic coarse sediment dominated by sand digger shrimp (Bathyporeia pilosa)	LC	A1
NE	AA.I4U	Baltic photic coarse sediment characterized by no macrocommunity	LC	A1
NE	AA.J1B8	Baltic photic sand dominated by spikerush (Eleocharis spp.)	LC	A1
NE	AA.J1S2	Baltic photic sand dominated by Chorda fi lum and/or Halosiphon tomentosus	LC	A1
NE	AA.J3M5	Baltic photic sand dominated by multiple infaunal polychaete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor	LC	A1
NE	AA.J3N3	Baltic photic sand dominated by sand digger shrimp (Bathyporeia pilosa)	LC	A1
NE	AA.J3P1	Baltic photic sand dominated by midge larvae (Chironomidae)	LC	A1
NE	AA.J4U	Baltic photic sand characterized by no macrocommunity	LC	A1
NE	AA.M1C4	Baltic photic mixed substrate dominated by kelp	LC	A1
NE	AA.M1D	Baltic photic mixed substrate characterized by aquatic moss	LC	A1
NE	AA.M1E2	Baltic photic mixed substrate dominated by zebra mussel (Dreissena polymorpha)	LC	A1
NE	AA.M1F1	Baltic photic mixed substrate dominated by sea squirts (Ascidiacea)	LC	A1
NE	AA.M1G1	Baltic photic mixed substrate dominated by hydroids (Hydrozoa)	LC	A1
NE	AA.M1H1	Baltic photic mixed substrate dominated by crustose moss animals (Electra crustulenta)	LC	A1
NE	AA.M1I1	Baltic photic mixed substrate dominated by barnacles (Balanidae)	LC	A1

NE	AA.M1J	Baltic photic mixed substrate characterized by epibenthic sponges (Porifera)	LC	A1
NE	AA.M1Q1	Baltic photic mixed substrate dominated by stable aggregations of unattached Fucus spp. (typical form)	LC	A1
NE	AA.M1R	Baltic photic mixed substrate characterized by soft crustose algae	LC	A1
NE	AA.M1S2	Baltic photic mixed substrate dominated by Chorda fi lum and/or Halosiphon tomentosus	LC	A1
NE	AA.M2W	Baltic photic mixed substrate characterized by microphytobenthic organisms and grazing snails	LC	A1
NE	AA.M2T	Baltic photic mixed substrate characterized by sparse epibenthic macrocommunity	LC	A1
NE	AA.M4U	Baltic photic mixed substrate characterized by no macrocommunity	LC	A1
NE	AB.A2T	Baltic aphotic rock and boulders characterized by sparse epibenthic macrocommunity	LC	A1
NE	AB.A4U	Baltic aphotic rock and boulders characterized by no macrocommunity	LC	A1
NE	AB.B1E1	Baltic aphotic hard clay dominated by Mytilidae	LC	A1
NE	AB.C	Baltic aphotic marl (marlstone rock)	LC	A1
NE	AB.E1E1	Baltic aphotic shell gravel dominated by Mytilidae	LC	A1
NE	AB.F	Baltic aphotic ferromanganese concretion bottom	LC	A1
NE	AB.H1K1	Baltic aphotic muddy sediment dominated by tube-building polychaetes	LC	A1
NE	AB.H3M3	Baltic aphotic muddy sediment dominated by Marenzelleria spp.	LC	A1
NE	AB.H3M6	Baltic aphotic muddy sediment dominated by various opportunistic polychaetes	LC	A1
NE	AB.H3P1	Baltic aphotic muddy sediment dominated by midge larvae (Chironomidae)	LC	A1
NE	AB.I3N3	Baltic aphotic coarse sediment dominated by sand digger shrimp (Bathyporeia pilosa)	LC	A1
NE	AB.I4U1	Baltic aphotic coarse sediment dominated by meiofauna	LC	A1
NE	AB.J3M5	Baltic aphotic sand dominated by multiple infaunal polychaete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor	LC	A1
NE	AB.J3N1	Baltic aphotic sand dominated by Monoporeia affinis and Saduria entomon	LC	A1
NE	AB.J3P1	Baltic aphotic sand dominated by midge larvae (Chironomidae)	LC	A1
NE	AB.J4U1	Baltic aphotic sand dominated by meiofauna	LC	A1
NE	AB.M2T	Baltic aphotic mixed substrate characterized by sparse epibenthic macrocommunity	LC	A1
NE	AA.A1C	Baltic photic rock and boulders characterized by perennial algae	NE	
NE	AA.J1A	Baltic photic sand characterized by emergent vegetation	NE	
NE	AA.J1B	Baltic photic sand characterized by submerged rooted plants	NE	
NE	AA.I3O	Baltic photic coarse sediment characterized by infaunal echinoderms	NE	
NE	AA.I3P	Baltic photic coarse sediment characterized by infaunal insect larvae	NE	
NE	AA.I3M	Baltic photic coarse sediment characterized by infaunal polychaetes	NE	

NE	AA.I3N	Baltic photic coarse sediment characterized by infaunal crustaceans	NE
NE	AA.J1E	Baltic photic sand characterized by epibenthic bivalves	NE
NE	AA.J1Q	Baltic photic sand characterized by stable aggregations of unattached perennial vegetation	NE
NE	AA.I2T	Baltic photic coarse sediment characterized by sparse epibenthic macrocommunity	NE
NE	AA.I3L	Baltic photic coarse sediment characterized by infaunal bivalves	NE
NE	AA.J1S	Baltic photic sand characterized by annual algae	NE
NE	AA.J1V	Baltic photic sand characterized by mixed epibenthic macrocommunity	NE
NE	AA.J3L	Baltic photic sand characterized by infaunal bivalves	NE
NE	AA.I1V	Baltic photic coarse sediment characterized by mixed epibenthic macrocommunity	NE
NE	AA.I1S	Baltic photic coarse sediment characterized by annual algae	NE
NE	AA.I1Q	Baltic photic coarse sediment characterized by stable aggregations of unattached perennial vegetation	NE
NE	AA.J3M	Baltic photic sand characterized by infaunal polychaetes	NE
NE	AA.J3N	Baltic photic sand characterized by infaunal crustaceans	NE
NE	AA.J3P	Baltic photic sand characterized by infaunal insect larvae	NE
NE	AA.K	Baltic photic hard anthropogenically created substrates	NE
NE	AA.L	Baltic photic soft anthropogenically created substrates	NE
NE	AA.M1A	Baltic photic mixed substrate characterized by emergent vegetation	NE
NE	AA.M1B	Baltic photic mixed substrate characterized by submerged rooted plants	NE
NE	AA.I1E	Baltic photic coarse sediment characterized by epibenthic bivalves	NE
NE	AA.M1C	Baltic photic mixed substrate characterized by perennial algae	NE
NE	AA.M1E	Baltic photic mixed substrate characterized by epibenthic bivalves	NE
NE	AA.M1F	Baltic photic mixed substrate characterized by epibenthic chordates	NE
NE	AA.M1G	Baltic photic mixed substrate characterized by epibenthic cnidarians	NE
NE	AA.M1H	Baltic photic mixed substrate characterized by epibenthic moss animals (Bryozoa)	NE
NE	AA.I1C	Baltic photic coarse sediment characterized by perennial algae	NE
NE	AA.M1I	Baltic photic mixed substrate characterized by epibenthic crustacea	NE
NE	AA.M1Q	Baltic photic mixed substrate characterized by stable aggregations of unattached perennial vegetation	NE
NE	AA.I1B	Baltic photic coarse sediment characterized by submerged rooted plants	NE

NE	AA.M1S	Baltic photic mixed substrate characterized by annual algae	NE
NE	AA.M1V	Baltic photic mixed substrate characterized by mixed epibenthic macrocommunity	NE
NE	AB.A1E	Baltic aphotic rock and boulders characterized by epibenthic bivalves	NE
NE	AB.A1F	Baltic aphotic rock and boulders characterized by epibenthic chordates	NE
NE	AB.A1G	Baltic aphotic rock and boulders characterized by epibenthic cnidarians	NE
NE	AA.H4U	Baltic photic muddy sediment characterized by no macrocommunity	NE
NE	AB.A1H	Baltic aphotic rock and boulders characterized by epibenthic moss animals (Bryozoa)	NE
NE	AA.H3P	Baltic photic muddy sediment characterized by infaunal insect larvae	NE
NE	AB.A1I	Baltic aphotic rock and boulders characterized by epibenthic crustacea	NE
NE	AA.H3N	Baltic photic muddy sediment characterized by infaunal crustaceans	NE
NE	AA.I1A	Baltic photic coarse sediment characterized by emergent vegetation	NE
NE	AB.A1V	Baltic aphotic rock and boulder characterized by mixed epibenthic macrocommunity	NE
NE	AB.B1E	Baltic aphotic hard clay characterized by epibenthic bivalves	NE
NE	AA.H3M	Baltic photic muddy sediment characterized by infaunal polychaetes	NE
NE	AB.B1V	Baltic aphotic hard clay characterized by mixed epibenthic macrocommunity	NE
NE	AB.B2T	Baltic aphotic hard clay characterized by sparse epibenthic macrocommunity	NE
NE	AB.B4U	Baltic aphotic hard clay characterized by no macrocommunity	NE
NE	AA.H1V	Baltic photic muddy sediment characterized by mixed epibenthic macrocommunity	NE
NE	AA.H3L	Baltic photic muddy sediment characterized by infaunal bivalves	NE
NE	AB.E1E	Baltic aphotic shell gravel characterized by epibenthic bivalves	NE
NE	AA.H1S	Baltic photic muddy sediment characterized by annual algae	NE
NE	AB.E1F	Baltic aphotic shell gravel characterized by epibenthic chordates	NE
NE	AB.E1V	Baltic aphotic shell gravel characterized by mixed epibenthic macrocommunity	NE
NE	AB.E2T	Baltic aphotic hard clay characterized by sparse epibenthic macrocommunity	NE
NE	AB.E3X	Baltic aphotic shell gravel characterized by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments	NE
NE	AA.H1Q	Baltic photic muddy sediment characterized by stable aggregations of unattached perennial vegetation	NE
NE	AB.E4U	Baltic aphotic shell gravel characterized by no macrocommunity	NE
NE	AB.G	Baltic aphotic peat bottoms	NE

NE	AB.H1E	Baltic aphotic muddy sediment characterized by epibenthic bivalves	NE
NE	AB.H1G	Baltic aphotic muddy sediment characterized by epibenthic cnidarians	NE
NE	AB.H1I	Baltic aphotic muddy sediment characterized by epibenthic crustacea	NE
NE	AB.H1K	Baltic aphotic muddy sediment characterized by epibenthic polychaetes	NE
NE	AB.H1V	Baltic aphotic muddy sediment characterized by mixed epibenthic macrocommunity	NE
NE	AB.H2T	Baltic aphotic muddy sediment characterized by sparse epibenthic macrocommunity	NE
NE	AA.H1E	Baltic photic muddy sediment characterized by epibenthic bivalves	NE
NE	AB.H3L	Baltic aphotic muddy sediment characterized by infaunal bivalves	NE
NE	AA.H1B	Baltic photic muddy sediment characterized by submerged rooted plants	NE
NE	AB.H3M	Baltic aphotic muddy sediment characterized by infaunal polychaetes	NE
NE	AB.H3N	Baltic aphotic muddy sediment characterized by infaunal crustaceans	NE
NE	AA.H1A	Baltic photic muddy sediment characterized by emergent vegetation	NE
NE	AB.H3O	Baltic aphotic muddy sediment characterized by infaunal echinoderms	NE
NE	AB.H3P	Baltic aphotic muddy sediment characterized by infaunal insect larvae	NE
NE	AB.H4U	Baltic aphotic muddy sediment characterized by no macrocommunity	NE
NE	AA.E1F	Baltic photic shell gravel characterized by epibenthic chordates	NE
NE	AA.E1V	Baltic photic shell gravel characterized by mixed epibenthic macrocommunity	NE
NE	AA.E2T	Baltic photic shell gravel characterized by sparse epibenthic macrocommunity	NE
NE	AA.E3X	Baltic photic shell gravel characterized by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments	NE
NE	AA.E4U	Baltic photic shell gravel characterized by no macrocommunity	NE
NE	AB.I1E	Baltic aphotic coarse sediment characterized by epibenthic bivalves	NE
NE	AB.I1V	Baltic aphotic coarse sediment characterized by mixed epibenthic macrocommunity	NE
NE	AB.I3L	Baltic aphotic coarse sediment characterized by infaunal bivalves	NE
NE	AA.E1C	Baltic photic shell gravel characterized by perennial algae	NE
NE	AA.E1E	Baltic photic shell gravel characterized by epibenthic bivalves	NE
NE	AB.I3M	Baltic aphotic coarse sediment characterized by infaunal polychaetes	NE
NE	AB.I3N	Baltic aphotic coarse sediment characterized by infaunal crustaceans	NE
NE	AB.I4U	Baltic aphotic coarse sediment chracterized by no macrocommunity	NE

NE	AB.J1E	Baltic aphotic sand characterized by epibenthic bivalves	NE
NE	AB.J1V	Baltic aphotic sand characterized by mixed epibenthic macroscopic community	NE
NE	AB.J3L	Baltic aphotic sand characterized by infaunal bivalves	NE
NE	AA.B1V	Baltic photic hard clay characterized by mixed epibenthic macrocommunity	NE
NE	AA.B2T	Baltic photic hard clay characterized by sparse epibenthic macrocommunity	NE
NE	AA.B4U	Baltic photic hard clay characterized by no macrocommunity	NE
NE	AA.B1E	Baltic photic hard clay characterized by epibenthic bivalves	NE
NE	AA.A1I	Baltic photic rock and boulders characterized by epibenthic crustacea	NE
NE	AB.J3M	Baltic aphotic sand characterized by infaunal polychaetes	NE
NE	AB.J3N	Baltic aphotic sand characterized by infaunal crustacea	NE
NE	AB.J3P	Baltic aphotic sand characterized by infaunal insect larvae	NE
NE	AB.J4U	Baltic aphotic sand characterized by no macrocommunity	NE
NE	AB.K	Baltic aphotic hard anthropogenically created substrates	NE
NE	AB.L	Baltic aphotic soft anthropogenically created substrates	NE
NE	AB.M1E	Baltic aphotic mixed substrate characterized by epibenthic bivalves	NE
NE	AB.M1F	Baltic aphotic mixed substrate characterized by epibenthic chordates	NE
NE	AB.M4U	Baltic aphotic mixed substrate characterized by no macrocommunity	NE
NE	AB.M1V	Baltic aphotic mixed substrate characterized by mixed epibenthic macrocommunity	NE
NE	AB.M1I	Baltic aphotic mixed substrate characterized by epibenthic crustacea	NE
NE	AB.M1H	Baltic aphotic mixed substrate characterized by epibenthic moss animals (Bryozoa)	NE
NE	AA.A1E	Baltic photic rock and boulders characterized by epibenthic bivalves	NE
NE	AA.A1F	Baltic photic rock and boulders characterized by epibenthic chordates	NE
NE	AA.A1G	Baltic photic rock and boulders characterized by epibenthic cnidarians	NE
NE	AB.M1G	Baltic aphotic mixed substrate characterized by epibenthic cnidarians	NE
NE	AA.A1H	Baltic photic rock and boulders characterized by epibenthic moss animals (Bryozoa)	NE
NE	AA.H1K	Baltic photic muddy sediment characterized by epibenthic polychaetes	NE

Annex 2
Pelagic habitat threat categories

Download the Excel sheet (.XLSX) here.

Red List II 2024	Criteria 2024	HUB code	HUB name	Red List 2013	Criteria 2013
EN	A1, A2a	AC	*Baltic Sea seasonal Ice*	VU	A1, A2a
NE		AE.O5	Baltic Sea aphotic pelagic below halocline oxic	EN	A3
NE		AD.N5	Baltic Sea Photic Pelagic above halocline oxic	LC	A1
NE		AE.N5	Baltic Sea Aphotic Pelagic above halocline oxic	LC	A1
NE		AE.N6	Baltic Sea Aphotic Pelagic above halocline anoxic	LC	A1
NE		AE.O6	Baltic Sea Aphotic Pelagic below halocline anoxic	LC	A1

Annex 3
Biotope complexes threat categories

Download the Excel sheet (.XLSX) here.

Comparisons between 2013 and 2024 results should consider the shift in methodology from expert opinion to a data-driven approach.

Red List II 2024	Criteria 2024	HUB code	Biotope complexes	Red List 2013	Criteria 2013
EN	C1	1130	Estuaries	CR	C1
EN	B2c(ii)	1180	Submarine structures made by leaking gases	EN	B2c(ii)
EN	C1	1150	Coastal lagoons	EN	C1
EN	C1	1140	Mudflats and sandflats not covered by seawater at low tide	VU	C1
EN	C1	1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation	NT	C1
VU	C1	1160	Large shallow inlets and bays	VU	C1
VU	C1	1620	Boreal Baltic islets and small islands	NT	C1
NE		1110	Sandbanks which are slightly covered by sea water all the time	VU	C1
NE		1170	Reefs	VU	C1
NE		1650	Boreal Baltic narrow inlets	VU	C1

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