1. Introduction

1.1. Why is a holistic assessment of the Baltic Sea needed?

Achieving good ecosystem health is a core area of collaboration among countries bordering the Baltic Sea, which make up the Contracting Parties to HELCOM. Pressures from various human activities have an impact on Baltic Sea ecosystems, affecting the status of species and habitats, as well as human well-being. The close links between different parts of the Baltic Sea mean that actions often have to be coordinated across national borders for environmental measures to be effective. Environmental pressures vary spatially and their importance can change over time, depending on how human activities develop and on how efficiently we are able to manage and minimize negative impacts.

The third HELCOM holistic assessment (HOLAS 3) provides a wide-ranging update on the environmental status of the Baltic Sea for the time period 2016–2021. The holistic assessment helps us understand which pressures are currently of key importance and what areas will require additional measures, assuming current management measures are effective and are sufficient.

This holistic assessment captures a snapshot in time, reflecting the environmental condition and the role contemporary society plays in the dynamic life history of the Baltic Sea. In producing the assessment, researchers and experts around the Baltic Sea share insights into the various aspects that drive changes in its ecosystem. The task is not trivial. Different pressures often interact within the societal, economic and ecological complexity encompassing the Baltic Sea environment, and the effects on species and habitats may occur with a time lag or may be expressed differently between species or areas. It is crucial to produce an overview of the whole system that is as comprehensive and accurate as possible. Together, we want to understand which activities put pressures on the ecosystem and how they do so, how those pressures affect the state of the environment and biodiversity (in other words the species and habitats of the Baltic Sea), how the ecosystem and its functions are altered, and how such changes influence or can be influenced by societal factors. We want to use these insights to define new actions to renew, update and establish more effective measures to ensure a healthy Baltic Sea.

1.2. Policy use

In HELCOM, the holistic assessment provides a shared basis for following up on progress towards the objectives of the Baltic Sea Action Plan, facilitating the adaptive development of measures for the Baltic Sea environment in alignment with the ecosystem approach (Box 1.1).

The results and evaluations can be used to assess the current environmental status of the Baltic Sea and track the progress and effects of existing measures. This work supports several policies of key importance for the marine environment, helping HELCOM countries to come together and agree on the next steps to curb negative impacts and improve the status of the Baltic Sea.

1.2.1 Baltic Sea Action Plan

The Baltic Sea Action Plan (BSAP) is HELCOM's strategic programme of measures and actions for achieving a good environmental status of the sea (HELCOM 2021). The BSAP provides the concrete basis for work in HELCOM by stimulating goal-oriented cooperation among countries in the Baltic Sea region.

The BSAP is guided by the HELCOM vision of "a healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities". The 2021 BSAP is divided into four segments, each with specific goals and objectives, which have been jointly agreed amongst the Baltic Sea countries (Figure 1.1).

Each of the four segments contains concrete measures and actions to be implemented by 2030 at the latest.

The *Eutrophication* and *Hazardous substances and litter* segments mainly reflect actions needed to manage pressures stemming from land, while the *Sea-based activities* segment addresses actions needed at sea to curb negative impacts resulting from our marine activities. The segments of the BSAP are intrinsically linked, and accomplishing the goals of these segments has direct importance for securing the status of species and habitats in the Baltic Sea, which is the target of the *Biodiversity* segment. The actions under this segment focus primarily on protection and restoration.

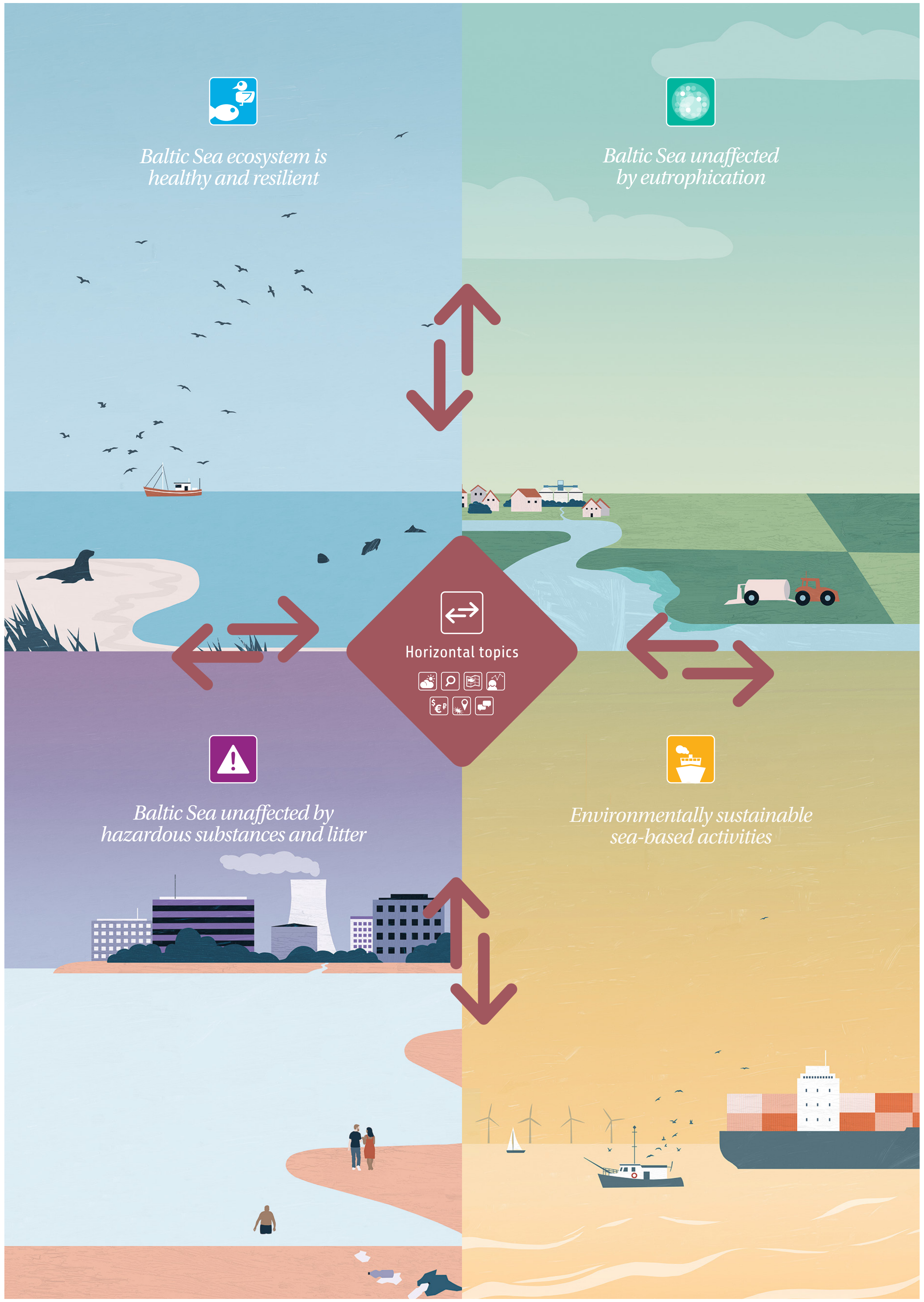

Figure 1.1. The four main segments of the Baltic Sea Action Plan (BSAP) focus on Biodiversity, Eutrophication, Hazardous substances and litter, and Sea-based activities. These segments support each other and share cross-cutting topics. The cross-cutting topic of the BSAP are climate change, monitoring, maritime spatial planning, economic and social analyses, knowledge exchange and awareness raising, hot spots, and financing.

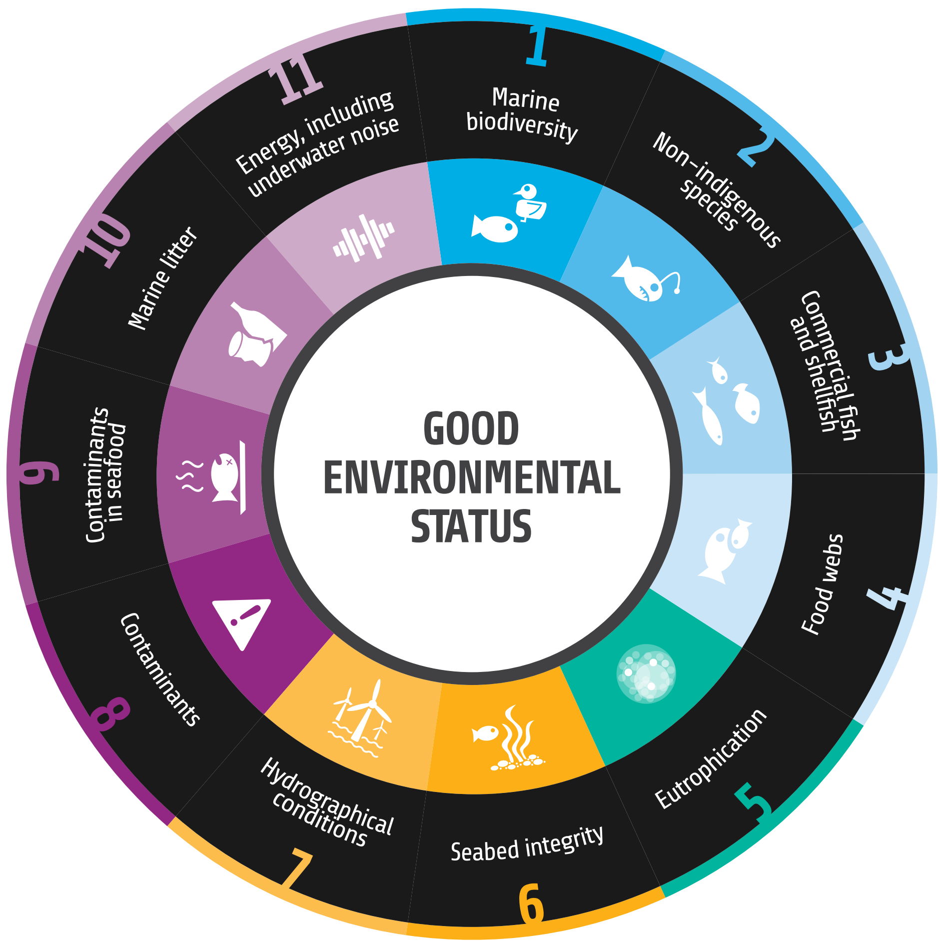

Figure 1.2. The EU Marine Strategy Framework Directive aims for good environmental status based on eleven descriptors covering different aspects of the marine environment

The BSAP also includes a number of horizontal topics. These address cross-cutting issues which have the potential to markedly influence the successful implementation of the BSAP. These include climate change, monitoring, maritime spatial planning, economic and social analyses, knowledge exchange and awareness raising, hot spots and financing.

1.2.2 Marine Strategy Framework Directive and other EU legislation

The Marine Strategy Framework Directive (MSFD) is the legal instrument for the protection of the seas in the European Union. The overarching goal of the MSFD is to achieve a good environmental status of the marine waters within the European Union, which is specified using eleven descriptors (Figure 1.2). EU Member States are required to report on the status of their marine environments (using indicators) in relation to these descriptors in six-year assessment cycles (EC 2017 a,b). While member states define the indicators and their threshold values, they are often required to do so through regional cooperation, and their data collection and assessment approaches need to be as coherent as possible in order to be meaningful, particularly within the same marine region.

The MSFD is an overarching framework that strives to establish an ecosystem-based, adaptive, and integrated approach to the management of all human activities that have an impact on the marine environment. The MSFD does not aim to replace other related EU policies but makes links to them to support harmonised assessment and monitoring. Examples of EU policies of direct relevance for the implementation of the EU MSFD are the Birds and Habitats Directive (EU 1992), the Water Framework Directive (EC 2000), and the EU Common Fisheries Policy (EU 2013).

1.2.3 The Global Sustainable Development Goals

The HELCOM Baltic Sea Action Plan and HELCOM activities are well aligned with the Sustainable Development Goals of the United Nations (Figure 1.3), which provide a global blueprint for peace and prosperity for people and our planet (UN 2015). The seventeen goals were adopted by all United Nations Member States in 2015. Rooted in an urgent call for action by both the Global South and the Global North, the Sustainable Development Goals recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth while tackling climate change and working to preserve our forests and oceans.

SDG targets addressed

— ***2.4*** *By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.*

— ***6.3*** *By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally*

— ***6.5*** *By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate*

— ***12.2*** *By 2030, achieve the sustainable management and efficient use of natural resources*

— ***12.4*** *By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment*

— ***12.5*** *By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse*

— ***13.2*** *Integrate climate change measures into national policies, strategies and planning*

— ***14.1*** *By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution*

— ***14.2*** *By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans*

— ***14.c*** *Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want*

— ***14.4*** *By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics*

— ***14.5*** *By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information*

— ***15.8*** *By 2020 introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems, and control or eradicate the priority species*

Biodiversity
Eutrophication
Hazardous substances, marine litter, underwater noise, non-indigenous species
Economic and social analyses
Spatial pressures and impacts

Figure 1.3. Sustainable Development Goals and their links with HOLAS 3, based on information in the 2021 HELCOM Baltic Sea Action Plan (BSAP).

BOX 1.1.

HELCOM policy and work are guided by the ecosystem approach

Marine governance following the ecosystem approach places ecosystem dynamics at the heart of the management of human activities and grounds policymaking in a scientific understanding of the environment. It focuses on the structure and functioning of the ecosystem as a whole, highlights our dependency on the health of the ecosystem, and acknowledges that different parts of the ecosystem are linked to each other. Ecosystem-based management necessitates the development of comprehensive integrated policies reaching across sectors and management levels. With an integrated perspective to the management of human activities, ecosystem-based management aims to ensure successful and sustainable societal and ecological outcomes. HELCOM contributes to the operationalization of ecosystem-based management throughout the implementation of the HELCOM Baltic Sea Action Plan.

1.3. Data and methods underlying the assessment

1.3.1 The HELCOM monitoring programmes

The holistic assessments are based on extensive data collected in a comparable manner throughout the Baltic Sea region to create the most accurate and comprehensive overview of the state of the Baltic Sea.

Maintaining regionally agreed monitoring programmes is a well-established function of HELCOM. Countries around the Baltic Sea carry out the monitoring in line with commonly agreed procedures and collate the data in centralized, open databases (HELCOM 2013a). Monitoring of the physical, chemical and biological variables of the Baltic Sea open sea area started as early as 1979, and monitoring of the input of nutrients and hazardous substances began in 1998. The monitoring programmes are developed continuously. There are now 40 jointly agreed HELCOM monitoring programmes being implemented by the countries around the Baltic Sea. These programmes cover the sources and inputs of human pressures and various variables that reflect the state of the environment. The monitoring data are used in various assessments to evaluate the state of the marine environment and to reveal long-term trends.

Despite recent developments to improve the assessment, several data gaps are still evident and need to be filled in future work. In some cases, data gaps exists because monitoring to support the assessed indicators (see Section 1.3.2) does not cover the full extent of the Baltic Sea region or there is insufficient sampling density. For some elements, regionally coordinated monitoring is still under development or is missing. More details for specific indicators and elements are given in the reports summarized in this report (HELCOM 2023a-e) and the indicator reports.

1.3.2 The HELCOM indicators

The HELCOM indicators are the basis for evaluating progress towards our identified objectives for the marine environment.

The indicators are developed by HELCOM expert groups following a set of key principles that address factors such as ecological relevance, policy relevance, measurability, and connection to human pressures. HELCOM core indicators must be quantitative and their underlying monitoring data and evaluation approaches must be harmonised across the Baltic Sea. The observed status of each core indicator in defined spatial units (see section 1.3.4) is evaluated against a regionally (or sub-regionally) agreed threshold value. Indicators are evaluated as either achieving or failing to achieve their threshold value. The evaluations thus help us understand the current situation in relation to our objectives, what direction we are moving in, and whether we need to take action (HELCOM 2020).

To avoid gaps in the holistic assessment and ensure that available knowledge of key importance is shared, the indicator evaluation results are supplemented with qualitative information for aspects that cannot be addressed quantitatively.

A central part of HELCOM's work is to develop and improve the set of indicators over time to enable better and more comprehensive assessments of the state of the environment and the pressures that affect it. There are currently almost 60 HELCOM indicators in use and reported in this assessment (Table 1.1).

Table 1.1. List of HELCOM indicators used in HOLAS 3.

Indicator name	Indicator category (Core, Pre-core, Supplementary, Element and Driver)
Distribution of Baltic grey seals	Core
Distribution of Baltic ringed seals	Core
Distribution of Baltic harbour seals	Core
Population trends and abundance of grey seals	Core
Population trends and abundance of ringed seals	Core
Population trends and abundance of harbour seals	Core
Nutritional status of seals	Core
Reproductive status of seals	Core
Harbour porpoise distribution	Pre-core
Harbour porpoise abundance	Pre-core
Abundance of waterbirds in the breeding season	Core
Abundance of waterbirds in the wintering season	Core
Breeding success of waterbirds	Pre-core
Number of drowned mammals and waterbirds in fishing gear	Core
Abundance of coastal fish key functional groups	Core
Abundance of key coastal fish species	Core
Size structure of coastal fish	Core
Abundance of salmon spawners and smolt	Core
Abundance of sea trout spawners and parr	Core
Zooplankton mean size and total stock	Core
Seasonal succession of dominating phytoplankton groups	Pre-core
Diatom/Dinoflagellate index	Pre-core
State of the soft-bottom macrofauna community	Core
Cumulative impact from physical pressures on benthic biotope (CumI)	Core
Baltic Sea acidification	Element
Inputs of nitrogen and phosphorous to the sub-basins	Core
Total nitrogen concentrations	Core
Total phosphorus concentrations	Core
Dissolved inorganic nitrogen (DIN)	Core
Dissolved inorganic phosphorus (DIP)	Core
Chlorophyll a	Core
Cyanobacterial bloom index	Pre-core
Water transparency	Core
Oxygen debt	Core
Shallow-water bottom oxygen	Core
Cadmium	Core
Copper	Core
Lead	Core
Mercury	Core
Hexabromocyclododecane (HBCDD)	Core
Polybrominated biphenyl ethers (PBDE)	State
Perfluorooctane sulphonate (PFOS)	Core
Polychlorinated biphenyls (PCB) and dioxins and furans	Core
Polyaromatic hydrocarbons (PAH) and their metabolites	Core

Table 1.1. (Continued). List of HELCOM indicators used in HOLAS 3.

Indicator name	Indicator category (Core, Pre-core, Supplementary, Element and Driver)
TBT and imposex	Core
Diclofenac	Pre-core
Radioactive substances: Cesium-137 in fish and surface waters	Core
White-tailed sea eagle productivity	Core
Reproductive disorders: Malformed amphipod embryos	Supplementary
Oil-spills affecting the marine environment	Core
Beach litter	Core
Litter on the seafloor	Pre-core
Continuous low frequency anthropogenic sound	Pre-core
Distribution in time and space of loud low- and mid-frequency impulsive sounds	Pre-core
Trends in arrival of new non-indigenous species	Core
Driver Indicator name	**Indicator category**
Fishery Operations	Driver
Total Allowable Catch	Driver
Agricultural Nutrient Balance	Driver
Wastewater Treatment	Driver

1.3.3 Integrated and thematic assessments

The integrated assessments combine indicator evaluation results and data to produce more holistic overviews of specific topics.

Different integrated assessment tools have been developed to address several of the themes covered by the holistic assessments. The BEAT tool addresses the biodiversity theme, HEAT addresses eutrophication, and CHASE is designed for the integrated assessment of hazardous substances. These tools all use HELCOM indicators as their basis. The tool outputs show whether the integrated status is good or not in five assessment result categories. The results thus also provide an understanding of how far we are from reaching good status. Two assessment categories represent different levels of good status and three represent different levels of not good status. The tools also produce assessments of confidence in the results, reflecting the spatial and temporal data quality as well as the confidence in the methodology and evaluation.

The SPIA tool, which can be used to show the spatial distribution of pressures and impacts, does not use indicators as a basis for its assessment. Instead, it spatially plots and integrates data on ecosystem components, such as species or habitats, as well as human activities, together with the pressure they can exert and their potential impact on the environment.

The integrated assessment tools are presented in more detail in the thematic assessments on biodiversity (HELCOM 2023a), eutrophication (HELCOM 2023b) and hazardous substances (HELCOM 2023c). Thematic assessments directly supporting this holistic assessment also cover economic and social analyses (HELCOM 2023d) and spatial analyses of pressures and impacts (HELCOM 2023e, see also Table 1.2).

1.3.4 HELCOM spatial assessment scales

The HELCOM spatial assessment units divide the Baltic Sea into ecologically relevant divisions with the aim of reporting indicator evaluations and integrated assessment results at their most ecologically relevant scale under a shared and coherent approach (Figure 1.4). The system is nested, which means that spatial assessment units with higher spatial resolution can fit into units with lower spatial resolution (with a few minor exceptions). The applied levels of scale are:

- Level 1. HELCOM Marine area: The whole Baltic Sea, encompassing the entire HELCOM area,
- Level 2. HELCOM Subbasins: Division of the Baltic Sea into 17 subbasins,
- Level 3. HELCOM Subbasins with coastal and offshore divisions (national coastal areas)
- Level 4a. HELCOM Subbasins with coastal water types or water bodies aligned with the Water Framework Directive (WFD)
- Level 4b. HELCOM Subbasins with coastal WFD water types or water bodies with specific subdivisions for eutrophication assessment

In addition, assessments may be evaluated in aggregations of these assessment units where ecologically relevant (e.g., depending on population or species distribution extent).

1.3.5 Assessment period of HOLAS 3

The HELCOM holistic assessments provide recurrent updates on the state of the Baltic Sea over a given time period. Each HEL-

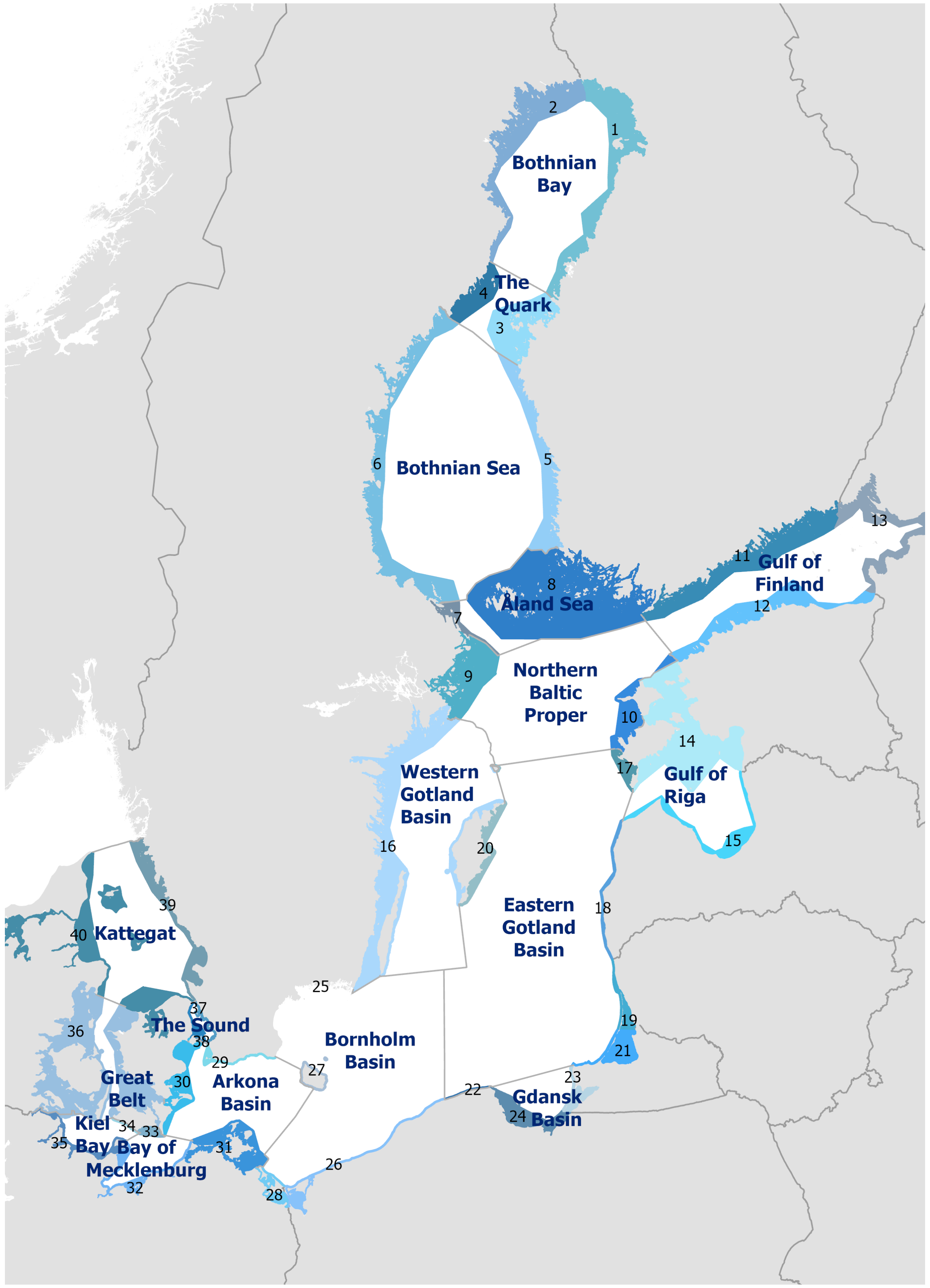

Figure 1.4. The spatial assessment units are a key tool for carrying out regional assessments coherently across the wide variety of topics and features of HOLAS while ensuring that each is assessed at an ecologically relevant scale.

Table 1.2. HOLAS 3 assessment products underpinning this summary report. In addition to these, introductory videos to explain concepts related to the assessments (developed primarily under the BLUES project) and other products to facilitate access to the HOLAS 3 results are available (see the State of the Baltic Sea website).

HOLAS 3 products
Thematic Assessments Reports: — Thematic assessment of biodiversity 2016-2021 — Thematic assessment of eutrophication 2016-2021 — Thematic assessment of hazardous substances, marine litter, underwater noise and non-indigenous species 2016-2021 — Thematic assessment of economic and social analyses 2016-2021 — Thematic assessment on spatial distribution of pressures and impacts 2016-2021
Updated data and data layers (HELCOM Map and Data Services)
59 indicator reports (see also Table 1.1)
HELCOM Metadata catalogue

COM holistic assessment covers a timespan of six years, referred to as the assessment period. The third HELCOM holistic assessment (HOLAS 3) focuses on the years 2016–2021. The HOLAS 3 assessment period partially overlaps with that of HOLAS II, which covered the period 2011-2016 (HELCOM 2018). The first HOLAS (HELCOM 2010) covered the years 2003-2007. These holistic assessments also aim to explore changes in status compared to prior assessment periods. Furthermore, the assessments reflect improvements in our understanding of how the components of the Baltic Sea ecological and societal systems are connected, incorporating enhancements in knowledge into each assessment.

1.4. How to read the summary report

The HELCOM holistic assessment is a multi-layered product representing varying levels of detail for each of the topics covered, and several assessment products underpin this summary report. Detailed data and results generated by national monitoring and regional data collection form the basis of the assessment, contributing to indicator evaluations. These, in turn, contribute to integrated results at overarching levels in the thematic assessments (HELCOM 2023a-e). This approach allows anyone to explore and utilise the results at whatever scale is most relevant while maintaining ecological relevance at the core.

The HELCOM indicator reports and thematic assessments directly underpin the results presented in this summary and offer more detailed and technical information (Table 1.2).

The aim of this summary report is to connect information from the underpinning assessment products to provide a more holistic view of the overall status of the Baltic Sea. The holistic approach strives to acknowledge the variety of roles that different species have in the ecosystems, as well as how they link together. The health and existence of each species in the Baltic Sea depends on interactions with several other species, habitats and environmental conditions, and each species fulfils certain ecological functions, many of which are vital for the ecosystem to function as a whole. An important implication is that the degradation of one element of the ecosystem, or the deterioration of one species, could damage other parts of the ecosystem. As will be evident from further reading, pressures and human-induced impacts can lead to modifications in the entire food web, leading to further reduced stability and resilience.

The summary report strives for a combined view and analysis of where we are today with the protection of the Baltic Sea environment and why the status is as it is. Our activities at sea and on land cause pressures on the marine environment, and these pressures have negative impacts on the species and habitats that we all depend for our survival and well-being. To keep the negative impact of our activities within the bounds that the ecosystem can tolerate, we must understand the effects of our actions and use that information to manage the activities that have a negative impact. This is accomplished by establishing well-founded and ecologically relevant targets and objectives to work towards and taking concrete measures to ensure we reach them. Figure 1.5 shows the management framework HELCOM works in and within which the holistic assessment is made. Observations of deteriorated species and habitats indicate the need for measures to stop the negative trends and restore ecosystems in order to realize sustainable outcomes for the natural environment and ourselves, now and in the future. The summary report aims to support further discussion and analysis of the actions we need to take to ensure a more sustainable future.

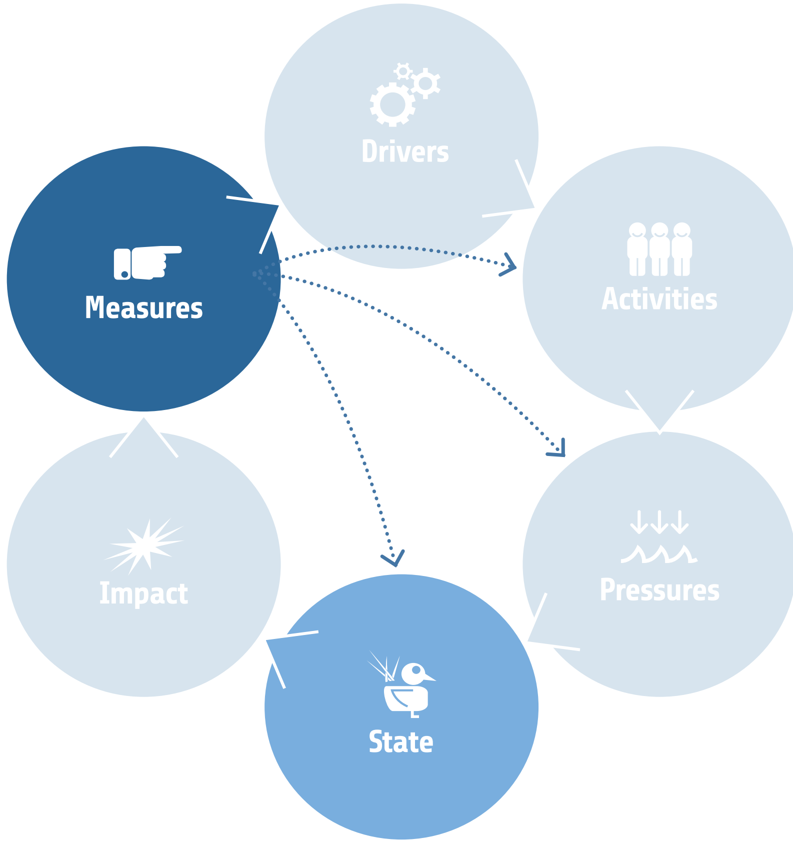

Figure 1.5. The conceptual management framework HELCOM works in and within which the holistic assessment is made. As a basis for further development of the holistic assessment, HELCOM has used a version of the Driver–Activities–Pressures–State–Impacts–Response (DAPSIR) framework, modified to fit the work under HELCOM and address the needs of the holistic assessment. This approach has been taken to strengthen the holistic aspect of the assessment, providing a clearer picture both of what we know across interlinked elements of the framework and of areas where further development or information is needed. In the modified management framework, Response has been replaced with Measures, reflecting the terminology used in the Baltic Sea Action Plan, and the definition of Impact has been expanded to include both perspectives presented in the assessment: impact on the environment and on society. The majority of the assessment work focuses on the environmental perspective (HELCOM 2023a, HELCOM 2023b, HELCOM 2023c, HELCOM 2023e), with the assessments presented under the Thematic Assessment on Economic and Social Analyses (HELCOM 2023d) representing the societal perspective.