3.2.1 The status of pelagic habitats

Pelagic habitats, including phytoplankton and zooplankton (Figure 3.2), do not have a good status in any of the fourteen open sea sub-basins assessed in 2016-2021 (Figure 3.3). The most deteriorated status occurs from the northern Baltic Proper and northwards, and the situation has worsened in the Bothnian Bay. The functioning of a pelagic habitat depends on its level of productivity, as well as on its species composition and the size structure of the species. The mean size of zooplankton has increased in some of assessed areas, which is a positive development, but the status of phytoplankton is generally not good. Four out of the thirteen assessed coastal areas have good status for phytoplankton. Eutrophication status and the status of pelagic habitats are closely interlinked. When the eutrophication indicators are also taken into account, no open sea or coastal pelagic habitats have good integrated status (HELCOM 2023a). This represents an unchanged situation since the previous assessment (HELCOM 2018).

Why is this important?

Functional pelagic habitats contribute to a wide range of ecosystem services and support the overall productivity of marine systems.

A poor status of pelagic habitats is associated with several ecological and socio-economic losses.

Effects of eutrophication are particularly evident in pelagic habitats, where they can lead to algal blooms and reduced water transparency, for example, with secondary impacts on benthic habitats, mobile species and human activities.

Eutrophication of the pelagic habitat also affect benthic habitats by contributing to poor oxygen conditions.

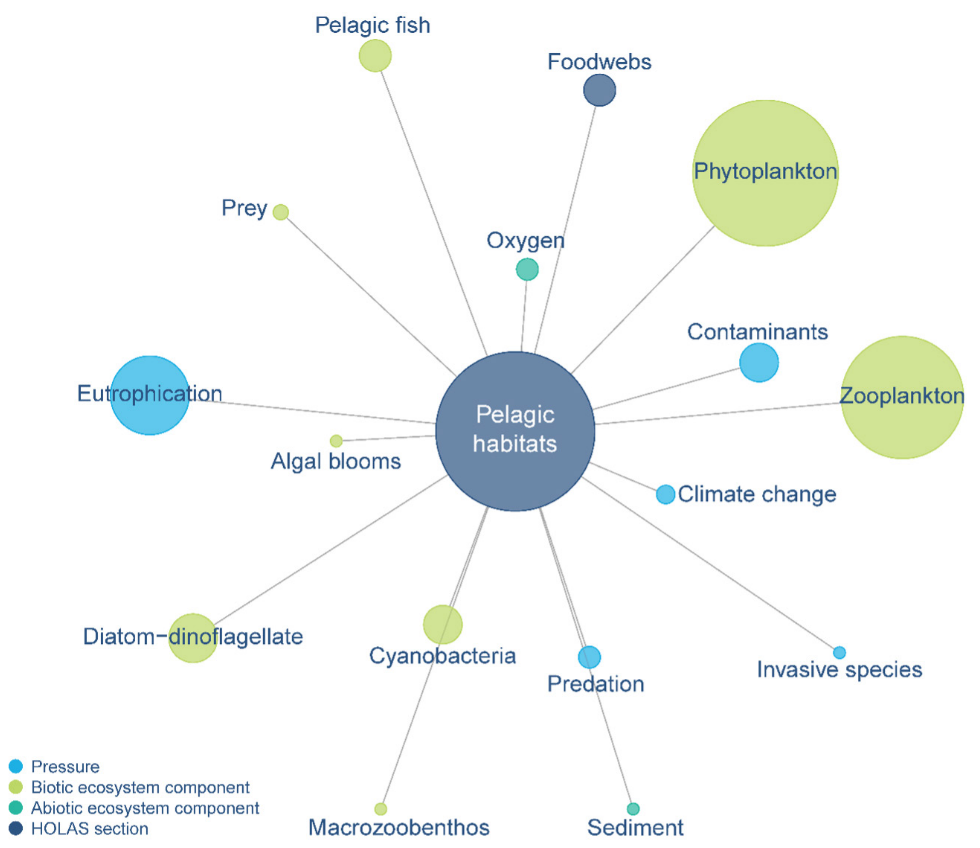

Figure 3.2. An overview of the ecosystem components and pressures descriptively linked to the status of pelagic habitats in HOLAS 3. The figure reflects aspects highlighted in the chapter on this topic in the HOLAS 3 thematic assessment report on biodiversity (HELCOM 2023a), based on the terms used and interlinkages made. The chapter itself is symbolised by the dark blue circle in the centre, and the other circles represent the key elements (terms) used in the chapter. The size of each circle is based on how often the term is mentioned in the chapter and should only be interpreted in this way. The terms are aggregated, so each circle includes both the term itself and all terms deemed to be synonymous (e.g. "eutrophication" includes "eutrophication" and associated terms such as "nutrient input" or "concentrations"). The width and length of the lines and the placement of the items is arbitrary. The image gives a simple visual representation of the topics covered in the evaluation, while simultaneously providing a gap analysis of where more information may be required in the future to increase the holistic nature of the evaluation (e.g. if an interaction between a certain pressure and an ecosystem component has not been well addressed). The overview was made using igraph.

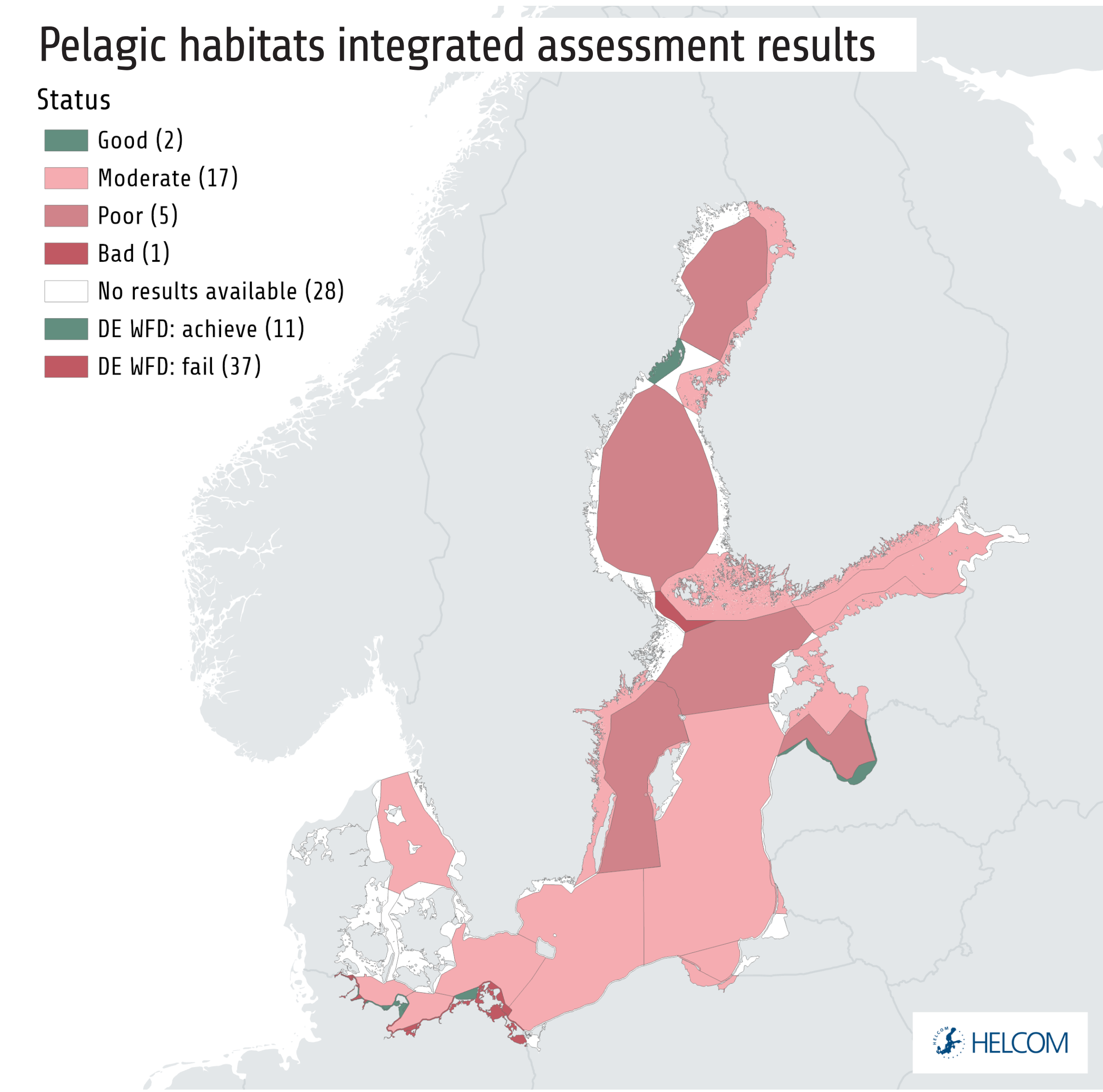

Figure 3.3. Summary of results from the integrated assessment of pelagic habitats. Source: HELCOM 2023a.

What can we do – what is affecting the status of pelagic habtats?

Pelagic habitats are directly affected by eutrophication because high nutrient levels enhance the productivity of phytoplankton. Eutrophication also affects the biodiversity of the phytoplankton community because some species benefit more than others. Zooplankton, which feed on phytoplankton, are affected by eutrophication if changes in the abundance and species composition of phytoplankton affect the availability or quality of their food. Moderate eutrophication is expected to benefit herbivorous zooplankton through increased food availability. However, high eutrophication is associated with algal blooms, which affect other species by decreasing water transparency. Blooms also affect other habitats because the organic materials produced sink down in the water column, decomposing closer to the seafloor and increasing oxygen consumption there (Figure 3.4). Reducing eutrophication is a key measure to improve the status of pelagic habitats in the Baltic Sea, as well as other habitats. The status of pelagic habitats is also affected to some extent by hazardous substances and non-indigenous species (HELCOM 2023a).

Maintaining the natural structure and ecological functions of food webs is expected to enhance the resilience of pelagic food webs to human pressures, including eutrophication. Species in the food web are closely connected, and they interact with each other through their feeding patterns. Thus, if consumer species are in good status, they can contribute to regulating fluctuations in the species that constitute their food. For example, phytoplankton abundance can be controlled through grazing by zooplankton, while the abundance of zooplankton, in turn, can be controlled by predation from higher trophic level species, such as other, larger zooplankton and pelagic fish.

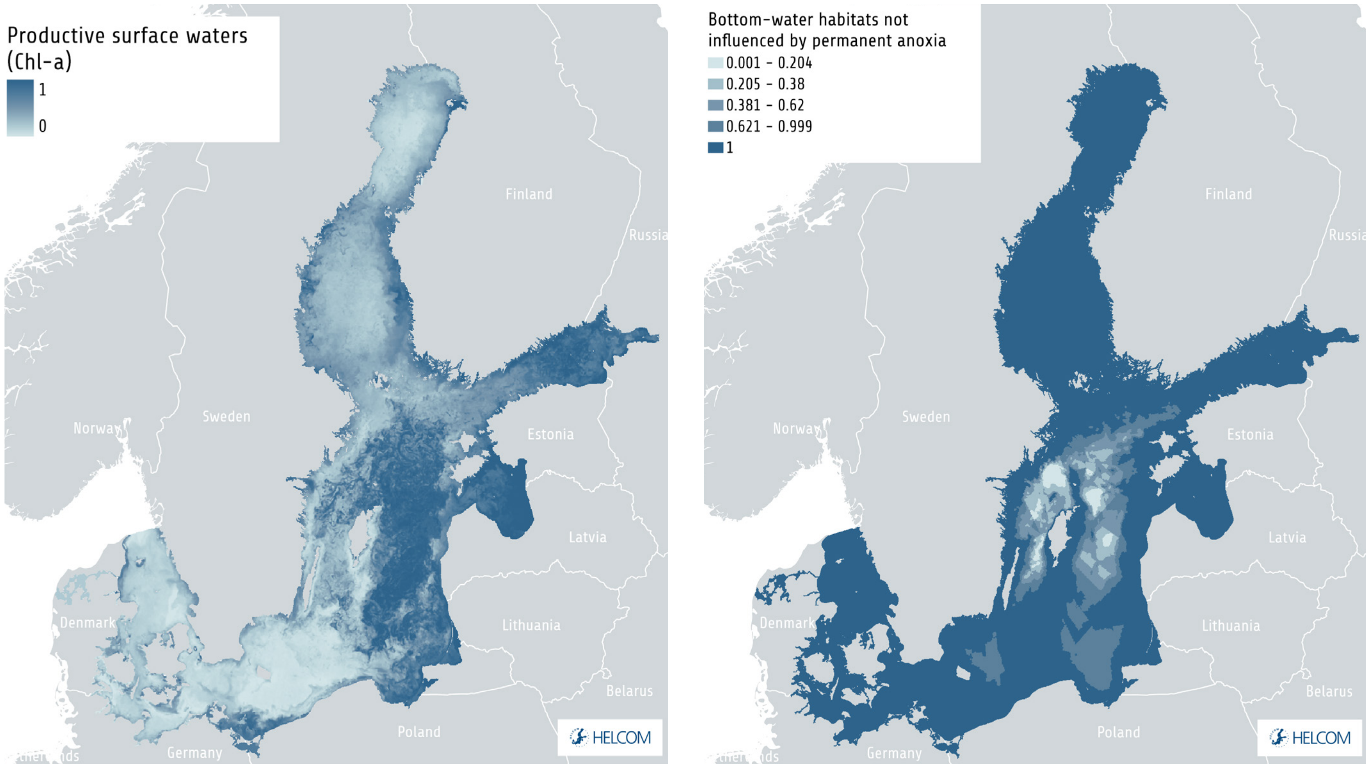

Figure 3.4. Distribution of pelagic habitat. Left: Productive surface waters are represented by the concentration of chlorophyll-a during spring. Higher values indicate areas with more chlorophyll-a in surface waters. The dataset was prepared by the Finnish Environment Institute. Right: Bottom-water habitats not influenced by permanent anoxia. Areas with low values are more influenced by anoxia. High values thus indicate suitable habitats for biota with respect to oxygen condition. The map was prepared based on the occurrence of hydrogen sulphide near the sea bottom. Importantly, the map only shows areas with permanent anoxia, and nformation on this is only available for open sea areas. Additional areas experience various degrees of temporary oxygen deficiency. For example, anoxia in coastal waters is often temporary in nature (HELCOM 2023h). Data were provided by the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) and are based on point measurements and modelling for five periods per year during 2016–2021. Source: HELCOM 2023e.

Effects of climate change on pelagic habitats

Various changes in the species composition and seasonality of pelagic communities are expected in a future climate (HELCOM/Baltic Earth 2021). For example, dinoflagellate blooms are assumed to increase, and diatom blooms decrease with increasing temperatures, although the associated processes are not yet fully understood. Worldwide, climate change is a significant driver of changes in zooplankton communities. However, what impacts this will have in the Baltic Sea is still uncertain.

Changes in the timing of spring blooms can occur due to changes in ice cover, cloudiness or wind condition (Kahru *et al.* 2014, 2016). This could have consequences for zooplankton and could also affect benthic productivity and fish if there is a mismatch between the time when food is available and the important recruitment periods.

The effects of climate change can also interact with other pressures. For example, increased pelagic primary productivity is mainly attributed to eutrophication (Saraiva *et al.* 2019), but warmer water may increase pelagic and benthic primary production (Kahru *et al.* 2016, Karlson *et al.* 2015, Lindegren *et al.* 2012, Hjerne *et al.* 2019, Suikkanen *et al.* 2013).

3.2.2 The status of benthic habitats

The status of benthic habitats (Figure 3.5) is assessed based on the status of soft-bottom macrofauna, shallow-water oxygen conditions, oxygen debt and the cumulative impact of physical pressures. Large parts of the benthic habitats in the southern Baltic Sea do not have a good integrated status, while the status is good in most of the open sea areas in the northern parts of the region (Figure 3.6). The vast majority of the coastal area, irrespective of its location, exhibits not good status (HELCOM 2023a). Of particular concern is the increasing extant of areas with poor or low oxygen in deep waters of the central Baltic Sea, which limits the populations of benthic fauna and impacts on overall ecosystem processes. The oxygen debt below the halocline has increased in all sub-basins since the early 1900s, especially in the Baltic Proper. The increase has been very steep between the previous and current assessment periods.

Why is this important?

Benthic habitats are widely distributed and contribute to various ecosystem services, including the assimilation, storage and sequestration of carbon and nutrients.

Many benthic animals have important regulatory roles by decomposing organic matter that sinks to the seabed or as grazers in shallow areas.

Benthic species are a fundamental food source for fish and birds and are therefore an important link between food web processes in benthic and pelagic habitats.

Seaweeds and plants in shallow areas are an important environment for many fish species.

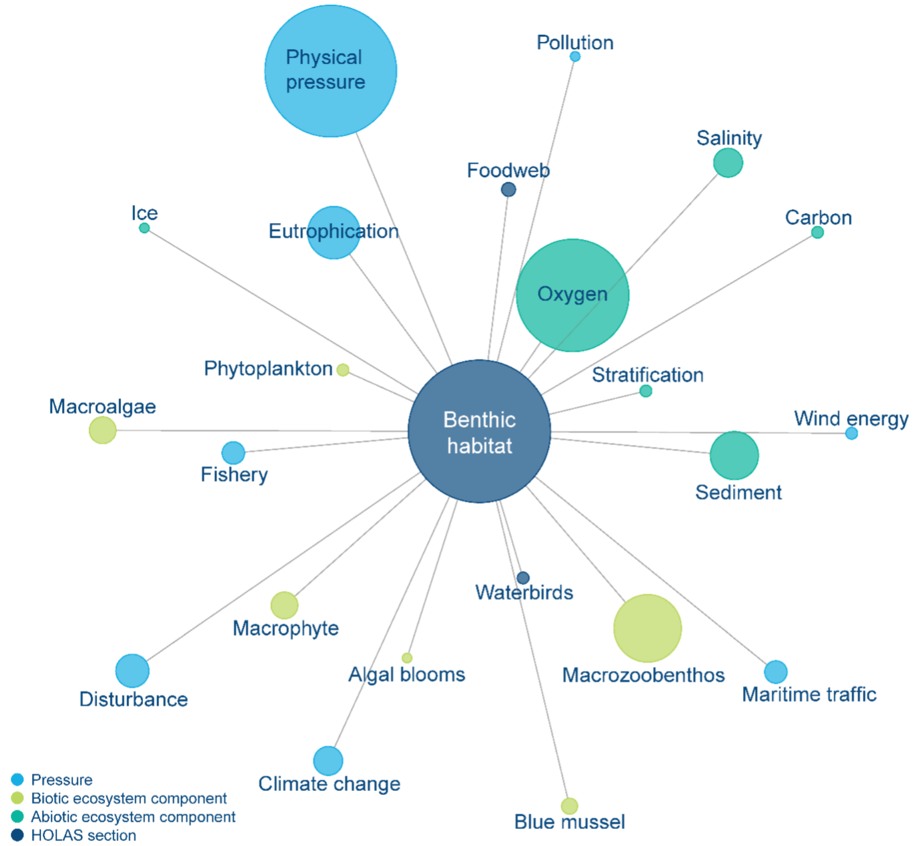

Figure 3.5. An overview of the ecosystem components and pressures descriptively linked to the status of benthic habitats in HOLAS 3. The figure reflects aspects highlighted in the chapter on this topic in the HOLAS 3 thematic assessment report on biodiversity (HELCOM 2023a), based on the terms used and interlinkages made. The chapter itself is symbolised by the dark blue circle in the centre, and the other circles represent the key elements (terms) used in the chapter. The size of each circle is based on how often the term is mentioned in the chapter and should only be interpreted in this way. The terms are aggregated, so each circle includes both the term itself and all terms deemed to be synonymous (e.g. "eutrophication" includes "eutrophication" and associated terms such as "nutrient input" or "concentrations"). The width and length of the lines and the placement of the items is arbitrary. The image gives a simple visual representation of the topics covered in the evaluation, while simultaneously providing a gap analysis of where more information may be required in the future to increase the holistic nature of the evaluation (e.g. if an interaction between a certain pressure and an ecosystem component has not been well addressed). The overview was made using igraph.