What can we do – what is affecting the status of fish in the Baltic Sea?

Overfishing has had a wide impact on fish stocks in the Baltic Sea. During the current assessment period, fishing mortality was too high for about half of the assessed stocks (HELCOM 2023a, section 4.3.1). Fish are also affected by eutrophication via its effects on habitat quality, prey abundance and feeding behavior.

Several cumulative pressures affect fish in coastal areas, including impacts on spawning areas, feeding and fish populations (Bergström *et al.* 2016, 2018, Moyano *et al.* 2022, Olsson *et al.* 2012, Olsson 2019, Snickars *et al.* 2015). The gradual reduction in the availability of important spawning and recruitment areas is a growing concern, as sheltered coastal areas and river mouths are often preferred areas for development and coastal construction (Seitz *et al.* 2014, Sundblad and Bergström 2014).

In the open sea, the currently most important spawning area for Eastern Baltic cod in the Bornholm Basin is now only a fraction of its historical area, because of oxygen deficiency. The Gdansk Basin and the Gotland Basin have had very limited contribution to cod recruitment since the 1990s (Köster *et al.* 2017).

Effects of climate change on fish

It is very likely that climate change is already affecting fish in the Baltic Sea, and that such effects will increase in the future. Climate change can affect fish directly, through effects on recruitment success and growth (Huss *et al.* 2019, 2021, Lindmark *et al.* 2022, Polte *et al.* 2021, van Dorst *et al.* 2019), or it may influence the distribution range of species, prey availability or the strength of other ecological interactions, for example (MacKenzie *et al.* 2007). Changes in temperature and seasonality may affect the length or onset of the reproductive season of fish, or alter the availability of zooplankton during critical life stages when fish are dependent on these for food (Polte *et al.* 2021). Decreases in surface water salinity could have a strong effect on fish community composition, if marine species in the Baltic Sea are disadvantaged and habitats suitable for freshwater species expand (Olsson *et al.* 2012, Koehler *et al.* 2022). Like any other organism, fish populations are more likely to tolerate external pressures when they are in a good status (Sumaila and Tai 2020). Reaching healthy fish populations in the Baltic Sea in the near future is crucial to build the ecosystem's resilience to future negative impacts of climate.

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3.2.4 Status of waterbirds

The overall status of waterbirds (Figure 3.10) is assessed as not good, although there is variability between groups with different feeding behaviour (Figure 3.11). Benthic feeders and waders do not have good status in any part of the region, while surface feeders have good status only in the Gulf of Bothnia. Grazing feeders do not have good status in the Kattegat, the Northern Baltic Proper, or the Åland Sea. Pelagic feeders have good status in several sub-basins. Many bird species characteristic of the Baltic Sea have decreased in abundance over the past decades, such as the pelagic-feeding great black-backed gull (*Larus marinus*) and the velvet scoter (*Melanitta fusca*), while a smaller number of species have increased, such as the greylag goose (*Anser anser*).

Why is this important?

Waterbirds are an integral part of the Baltic marine ecosystem, and their feeding behaviour also plays an important role in linking different parts of the ecosystem.

Waterbirds are a diverse group with various ecosystem functions. For example, they are predators of fish and macroinvertebrates, scavengers and herbivores

Waterbirds are unique in that they connect aquatic ecosystems with terrestrial ecosystems. Their long-distance migrations link the Baltic Sea with other marine regions.

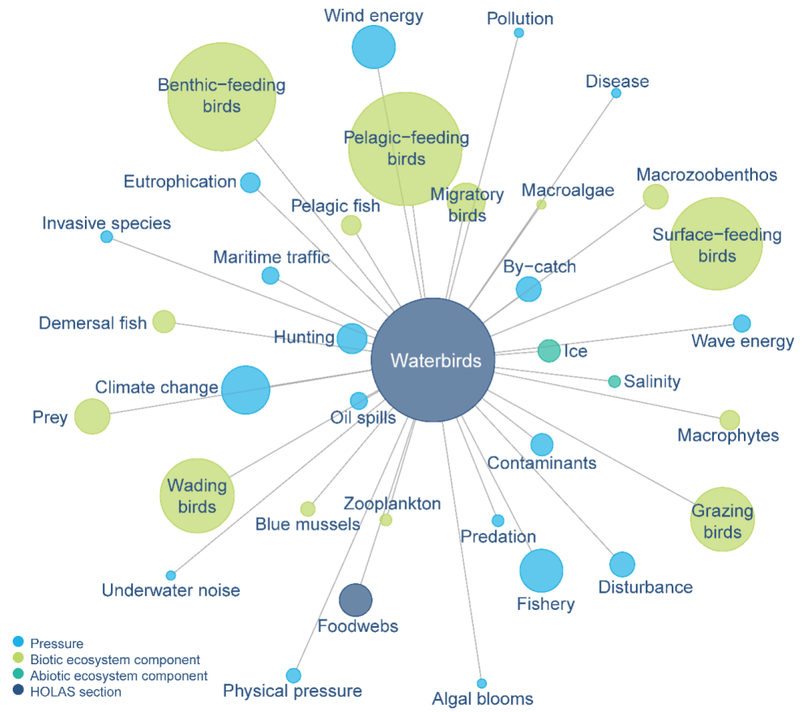

Figure 3.10. An overview of the ecosystem components and pressures descriptively linked to the status of waterbirds in HOLAS 3. The figure reflects aspects highlighted in the chapter on this topic in the HOLAS 3 thematic assessment report on biodiversity (HELCOM 2023a), based on the terms used and interlinkages 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.

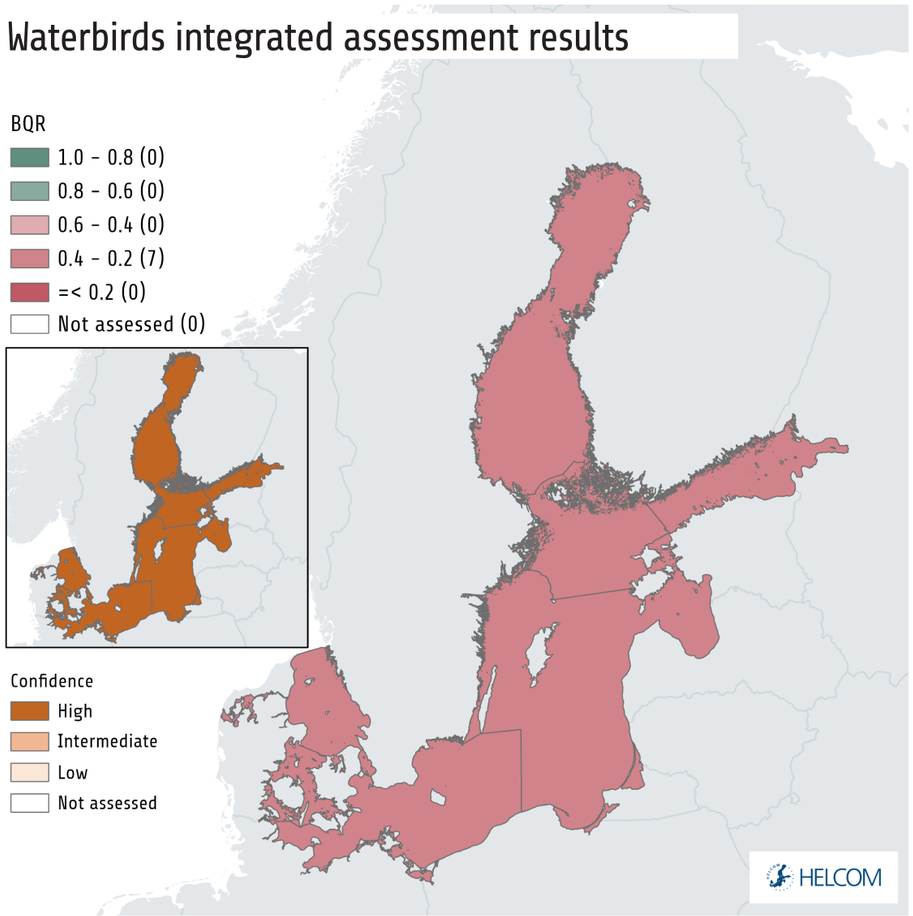

Figure 3.11. Summary of reults from the integrated assessment of waterbirds. Biological quality ratios (BQR) above 0.6 correspond to good status. Assessment confidence is presented in the map inserted to the left. Source: HELCOM 2023a.

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What can we do – what is affecting the status of waterbirds in the Baltic Sea?

The status of waterbirds is influenced by several factors, such as disruptions in the food web, habitat alterations, by-catches, hunting, oil spills and climate change. Importantly, the pressures from human activities typically have a cumulative impact on waterbird populations, and impacts on the status of waterbirds during the breeding season carry over to the status during the wintering season and vice versa. The need to address cumulative pressures is amplified by the fact that waterbirds are widely distributed, so impacts from multiple pressures can have an effect at the population level (Dierschke *et al.* 2012, Mercker *et al.* 2021).

Waterbirds respond strongly to food availability and impacts on their food sources readily carry over to effects on bird numbers. Fish-eating birds are sensitive to the depletion of fish populations. On the other hand, in cases where a depletion of large predatory fish has led to increases in the abundance of smaller fish species, through cascade effects, this has shown to improve the food supply for bird species preying on such smaller species. Food availability is also influenced by eutrophication status. While waterbird populations are likely food-limited under oligotrophic conditions, more nutrient-rich conditions can initially benefit them through an increased production of plants and benthic animals which they can feed on. However, extreme eutrophication will again lead to a decrease. The body condition of waterbirds is also affected by the accumulation of contaminants ingested via their food (Broman *et al.* 1990; Rubarth *et al.* 2011, Pilarczyk *et al.* 2012).

Unintentional by-catch in fishing gear is one important pressure of concern for waterbirds in the Baltic Sea. However, current estimates of the number of birds incidentally caught in fisheries are uncertain and are thought to be underestimations (Morkunas *et al.* 2022). Piscivorous birds (such as divers, grebes, mergansers, auks and cormorants) and benthic feeding ducks are particularly susceptible to entanglement and drowning in fishing gear. The by-catch problem is of special relevance when gillnet fishery is practised in areas with high densities of resting, moulting or wintering seabirds. The overlap of gillnet fishing and high bird density usually only occurs during certain periods of the year (e.g. wintering, autumn and spring migration or moulting time; Zydelis *et al.* 2009, Sonntag *et al.* 2012)).

Habitat alterations affect water birds through the draining of coastal meadows, the overgrowth of open areas, agricultural intensification or changes in arable land, for example. Such changes affect the breeding habitats and resting or wintering sites of waterbirds, and they can reduce the carrying capacity of certain wintering sites. Avoidance of offshore wind farms could become a concern for some species in the Baltic Sea in the future, such as divers and long-tailed ducks (Petersen *et al.* 2011, Dierschke *et al.* 2016). Diving ducks also avoid shipping lanes (Bellebaum *et al.* 2006, Schwemmer *et al.* 2011, Fliessbach *et al.* 2019). Benthic feeders are affected by habitat loss associated with physical disturbance of the seafloor (Cook & Burton 2010).

Large numbers of sea ducks are hunted, such as the common eider (*Somateria mollissima*), common goldeneye (*Bucephala clangula*), common long tailed duck (*Clangula hyemalis*) and common scoter (*Melanitta nigra*) (Mooij 2005, Skov *et al.* 2011, Lehikoinen *et al.* 2022).

Oil spills still occur in the Baltic Sea and causes oiled plumage, hypothermia and finally the death of waterbirds (Larsson & Tydén 2005, Žydelis *et al.* 2006).

As the majority of waterbirds in the Baltic Sea are migratory, it is important to note that extra-regional threats can also have a significant impact on their status. Changes in the availability and status of feeding and resting grounds during their migration and wintering periods can have a major influence (e.g. Piersma & Camphuysen 2001, Reneerkens *et al.* 2005).

Effects of climate change on waterbirds

Temperature increases will likely enable a northward expansion of several bird species during both wintering and the breeding season (Pavón-Jordán *et al.*, 2020, Fox *et al.* 2019), as has already been seen in goosander (*Mergus merganser*), the common goldeneye (*Bucephala clangula*) and the tufted duck (*Aythya fuligula*) (Lehikoinen *et al.* 2013), for example.

Some waterbirds that breed along the coasts of the Baltic Sea and formerly wintered further southwest, such as some diving duck species, now remain in the Baltic Sea during the winter (Skov *et al.* 2011, Nilsson & Haas 2016, Pavón-Jordán *et al.* 2020). When the birds' migratory distances shorten, this also reduces their energy demand (Lehikoinen *et al.* 2006, Gunnarsson *et al.* 2012). With milder spring temperatures and the related effects on vegetation and prey, many waterbirds arrive at their breeding area earlier in spring (Rainio *et al.* 2006, Vähätalo *et al.* 2004), and some start breeding earlier (van der Jeugd *et al.* 2009). Furthermore, the earlier loss of sea ice was found to improve the pre-breeding body condition of female common eiders, leading to increasing fledging success in offspring (Lehikoinen *et al.* 2006).

A rise in sea level would reduce the area of saltmarsh available to waders and other waterbirds for breeding and to geese for foraging (Clausen *et al.* 2013), particularly in the southern Baltic Sea. Other coastal habitats could be similarly affected (Clausen and Clausen 2014). Coastal breeding habitats may also undergo physical loss due to erosion. The combination of sea level rise and storms would also affect the breeding success of coastal waterbirds due to flooding of their breeding sites.

Changes in the occurrence pattern of diseases and parasites due to climate change can be expected to affect waterbirds in the Baltic (Fox *et al.* 2015).

Most waterbirds that breed in the region are migratory. The effects of climate change outside the Baltic region, such as in southern Europe and western Africa, thus also affect species that occur in the Baltic Sea (Fox *et al.* 2015).