Sources of underwater noise in the Baltic Sea

Continuous noise in the Baltic Sea comes mainly from maritime transport. Other sources of continuous noise include fishing vessels, energy installations, leisure boats and dredging. Noise from ships sailing at service speed is primarily from their engine and propeller, with secondary components being machinery and the movement of the hull through the water. Sound waves propagate efficiently in water, so sounds from point sources are heard much farther away than in air.

The most intense sources of loud impulsive noise are explosions, pile driving, seismic exploration and low frequency sonar. Unless mitigation measures are used to reduce the propagation of impulsive noise, activities such as explosions and piling may have effects at vast distances from the source. For example, impulsive noise input from pile driving activities was shown to induce avoidance reactions and thus disturbance to harbour porpoises at a distance of 25 km (Dähne *et al.* 2013). Effective mitigation measures exist to significantly reduce the effect distance and to temporarily deter animals from the remaining impacted area.

Regulations and needs

Reducing noise to levels that do not adversely affect marine life is a key management objective of the Baltic Sea Action Plan.

The envisaged revised International Maritime Organization Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life and the HELCOM Regional Action Plan on Underwater Noise are expected to lead to the achievement of this objective. However, compulsory regulations will likely be needed to achieve a significant reduction in underwater noise from shipping.

Furthermore, as spatial and temporal threshold values for underwater noise have just been adopted at the EU level, formal discussions and agreements are still needed about how these should be applied with respect to, for example, spatial assessment units, habitat size and sound levels that result in biologically adverse negative effects.

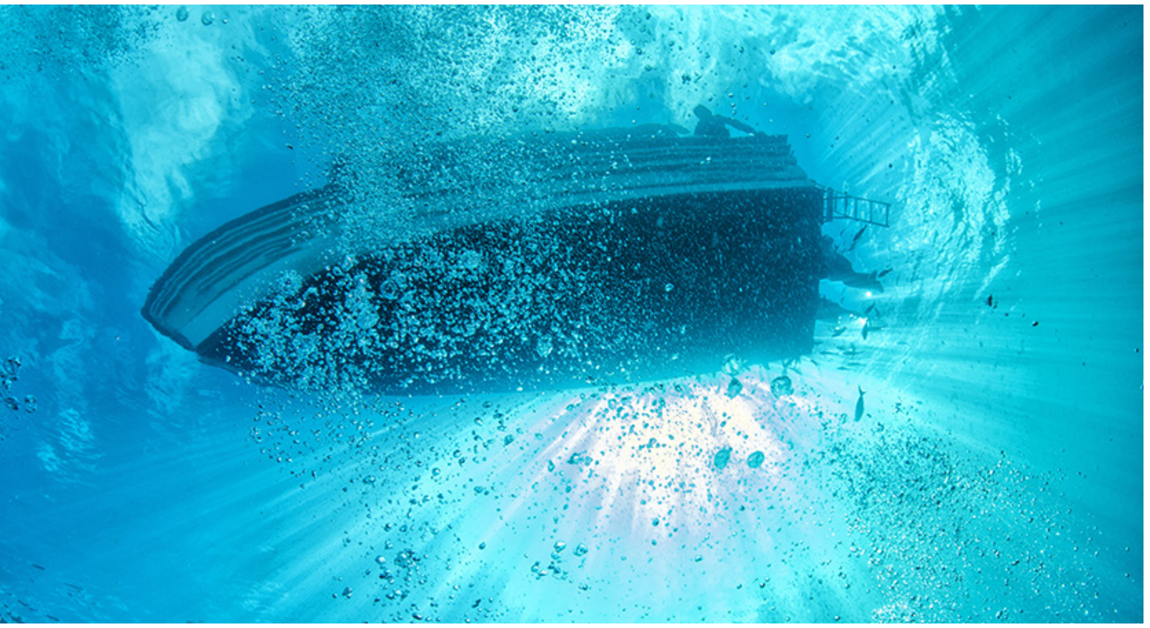

Figure 4.19. Contoinuous noise comes from boats and vessels of all sizes.

4.3. Pressures from activities at sea

Several pressures on the Baltic Sea derive from our direct use of the sea and its resources. Extractive pressures are associated with fishing, hunting and the extraction of materials from the seabed, such as sand and minerals. Physical pressures come from activities such as dredging, bottom trawling and marine construction.

The assessment results for pressures stemming from sea-based activities are presented here for the extraction of fish, unintentional by-catches, hunting of birds and mammals, and sea-floor loss and disturbance. More detailed results can be found in the HELCOM thematic assessment of biodiversity status (HELCOM 2023a) and its underlying indicator reports.

As these pressures are extractive or lead to physical alterations of the seabed, they have direct impacts on the affected species and habitats. Careful planning and regulation of the activities is needed to ensure sustainable use.

4.3.1 Extraction of fish

The status assessment of fish presented in Chapter 3 integrates the status of fishing pressure in the evaluation of commercially important fish stocks (Box 4.7). Out of fifteen commercial stocks that could be fully evaluated, only four showed good status on average during 2016-2021 (Figures 4.20-4.21). Stocks showing good status with respect to both fishing pressure and stock size were plaice in the Baltic Sea, herring in the Gulf of Riga and the Gulf of Bothnia, and vendace in the Swedish part of the Bothnian Bay, although the latter two stocks showed a decreasing trend in stock size.

Looking specifically at fishing pressure, threshold values were not achieved for eight of the seventeen stocks that could be evaluated for this indicator; these were four pelagic and four demersal stocks. Threshold values for stock size was not achieved for two pelagic stocks, four demersal stocks and eel (Table 4.1).

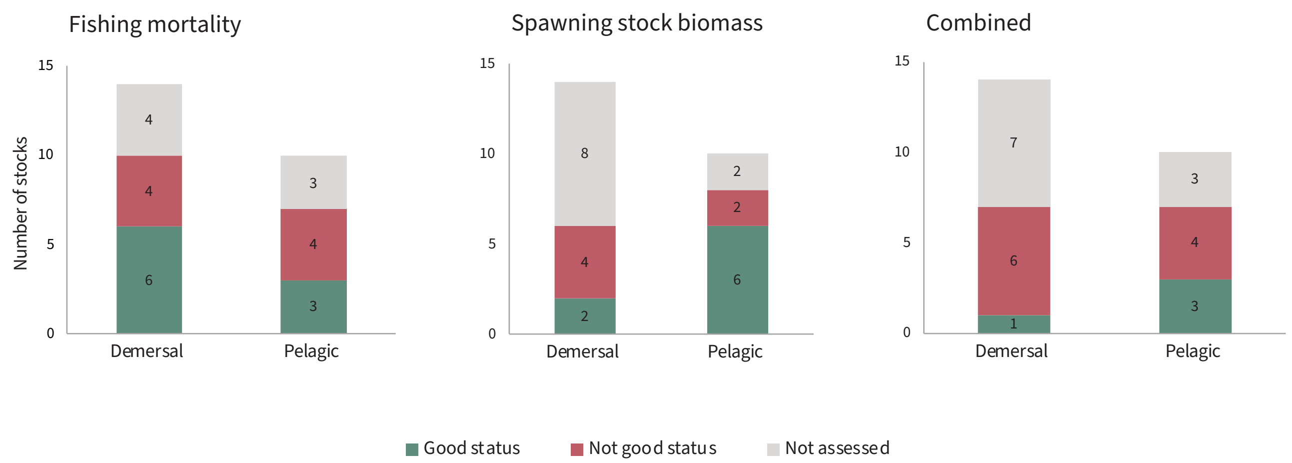

Figure 4.20. Number of pelagic and demersal commercial fish stocks in good and not good status with respect to fishing mortality (left), stock size (spawning stock biomass, middle), and both aspects combined (right). The colours denote whether the average value during 2016–2021 achieved (green) or failed (red) the 2021 threshold value. The number of fish stocks not assessed in each case is indicated in grey.

BOX 4.7.

What is commercial fishing and how is the status assessed?

Twenty-three fish and shellfish species are listed as commercially important in the Baltic Sea, based on that they together contributed to 98% of the accumulated landings in terms of weight or value during 2015-2019 (HELCOM 2021, see also ICES 2022a). Several of the species are divided into different stocks for fisheries management.

One of the central management objectives of the Baltic Sea Action Plan is that:

— **human-induced mortality, including hunting, fishing and incidental by-catch, does not threaten the viability of marine life**

The International Council for the Exploration of the Sea (ICES) provides advice on stock status and fishing opportunities on those commercial stocks that are internationally managed. These represent the largest part of all commercial landings in the Baltic Sea. Where data and models allow for an analytical assessment, individual stocks are assessed in relation to the management objective of reaching a Maximum Sustainable Yield. Assessment results are given with regard to the status of fishing mortality and spawning stock biomass (stock size). Where an analytical assessment is not possible, proxies are sometimes used. Nationally managed species are assessed by each country.

Based on stock assessment data, the status of fish stocks during 2016-2021 is evaluated against the condition that the average assessment ratio within the assessment period should achieve the reference values for indicators of both fishing mortality and stock size. Trends in age or size structure are included as supporting information but should be further developed in order to achieve full confidence in the assessment results.

Figure 4.21. Commercial fish photo.
© Juuso Haapaniemi

State of the Baltic Sea 2023
4. Protect and restore the Baltic Sea and its biodiversity

Table 4.1. Summary of status evaluation for commercial fish in the Baltic Sea region. Status of internationally managed fish stocks in the Baltic Sea during 2016–2021. Commercial fish species are assessed by stocks, which are named by their areal distribution. The numbers give the corresponding ICES assessment units (Subdivisions, SD). Total status is assessed by the condition that indicators of fishing mortality and stock size should both achieve their reference points, on average during 2016–2021. The symbols denote if each stock achieves (green) or fails (red) the set conditions. In addition, trends over the last ten years are indicated by arrows. The applied assessment approach is indicated as: MSY = analytical stock assessment, evaluated in relation to the MSY objective, PA = precautionary approach. Size or age structure was not evaluated in relation to a threshold value, but changes over the last ten years are indicated based on available data (1 = age structure 2 = length structure, 3 = qualitative assessment based on ICES advice). The evaluations of salmon and sea trout are based on many stocks, which show variable status. White circles denote that no status evaluation is available. The final column gives red list status according to HELCOM (2013c), which is the currently most recent HELCOM red list assessment but which does not match the HOLAS3 assessment period.

Species name (23)	Scientific name	Stocks (33)	Assessment approach	Fishing pressure		Stock size		Age/Size structure	Total	HELCOM Red List Status
				Status	Trend	Status	Trend	Trend		
Pelagic species										
Atlantic herring*	*Clupea harengus*	Skagerrak, Kattegat, W Baltic Spring spawners (SD 20-24)	MSY	🔴	→	🔴	↓	↑ 1	🔴	LC
		Central Baltic Sea (SD25-29 & SD32)	MSY	🔴	↑	🟢	↓	→ 1	🔴	
		Gulf of Riga (SD28)	MSY	🟢	→	🟢	↑	→ 1	🟢	
		Gulf of Bothnia (SD30-31)	MSY	🟢	→	🟢	↓	→ 1	🟢	
Sprat*	*Sprattus sprattus*	Baltic Sea (SD22-32)	MSY	🔴	→	🟢	→	→ 1	🔴	NA
Vendace**	*Coregonus albula*	Bothnian Bay (SWE, SD30)	MSY	🟢	↓	🟢	↓	↑ 2	🟢	-
		Bothnian Bay (FIN, SD30)	-	⚪	-	⚪	-	⚪	⚪	
Salmon*	*Salmo salar*	Baltic Sea, excl. Gulf of Finland (SD22-31)	MSY+PA	🔴	↓	🔴	↑	-	🔴	VU
		Gulf of Finland (SD32)	PA	⚪	-	🟢	-	-	⚪	
Sandeels (=Sandlances)*	*Ammodytes spp + Gymnoammodytes spp*	Skagerrak, Kattegat and Belt Sea (SD21-22)	PA	⚪	-	⚪	-	-	⚪	
Smelt	*Osmerus eperlanus*		-	⚪	-	⚪	-	-	⚪	NA
Demersal species										
Atlantic cod*	*Gadus morhua*	Kattegat (SD21)	PA	⚪	↑	🔴	↓	-	🔴	VU
		Western Baltic (SD22-24)	MSY	🔴	↓	🔴	↓	→ 1	🔴	
		Eastern Baltic (SD24-32)	PA	🔴	↓	🔴	↓	↓ 3	🔴	
Sole*	*Coregonus albula*	Skagerrak, Kattegat, and W Baltic Sea (SD20-24)	MSY	🟢	→	🔴	↑	-	🔴	NA
Dab*	*Limanda limanda*	Baltic Sea (SD22-32)	PA	🟢	-	⚪	→	→ 2	⚪	NA
Turbot*	*Scophthalmus maximus*	Baltic Sea (SD22-32)	PA	⚪	-	⚪	→	-	⚪	NT
Brill*	*Scophthalmus rhombus*	Baltic Sea (SD22-32)	PA	⚪	-	⚪	↑	-	⚪	
Plaice*	*Pleuronectes platessa*	Kattegat, Belt Sea, and the Sound (SD21-23)	MSY	🔴	↓	🟢	↑	↑ 1	🔴	NA
		Baltic Sea excl. Sound and Belt Sea (SD24-32)	MSY	🟢	→	🟢	↑	→ 2	🟢	
Baltic flounder*	*Platichthys solemdalii*	N Central and Northern Baltic Sea (SD 27, 29–32)	PA	🔴	-	⚪	→	-	🔴	
Flounders (European and Baltic)*	*Platichthys flesus + P.solemdalii*	Belt Sea and Sound (SD 22, 23)	PA	🟢	-	⚪	→	↓ 2	⚪	NA
		West of Bornholm, S Central Baltic (SD 24-25)	PA	🟢	-	⚪	→	→ 2	⚪	
		East of Gotland, Gulf of Gdansk (SD 26, 28)	PA	🟢	-	⚪	→	↓ 2	⚪	
Coastal species										
Eel*	*Anguilla anguilla*	Baltic Sea (SD22-32)	PA	⚪	-	🔴	-	-	🔴	CR
Sea trout*	*Salmo trutta*	Baltic Sea (SD22-32)	PA	⚪	-	⚪	-	-	⚪	VU
Whitefish	*Coregonus maraena*	-	-	⚪	-	⚪	-	-	⚪	EN
Perch	*Perca fluviatilis*	-	-	⚪	-	⚪	-	-	⚪	-
Roach	*Rutilus rutilus*	-	-	⚪	-	⚪	-	-	⚪	NA
Pikeperch	*Sander lucioperca*	-	-	⚪	-	⚪	-	-	⚪	NA
Pike	*Esox lucius*	-	-	⚪	-	⚪	-	-	⚪	NA
Bream	*Abramis brama*	-	-	⚪	-	⚪	-	-	⚪	NA
Blue mussel	*Mytilus edulis*	-	-	⚪	-	⚪	-	-	⚪	-

* Included in ICES advice, ** national data from Sweden

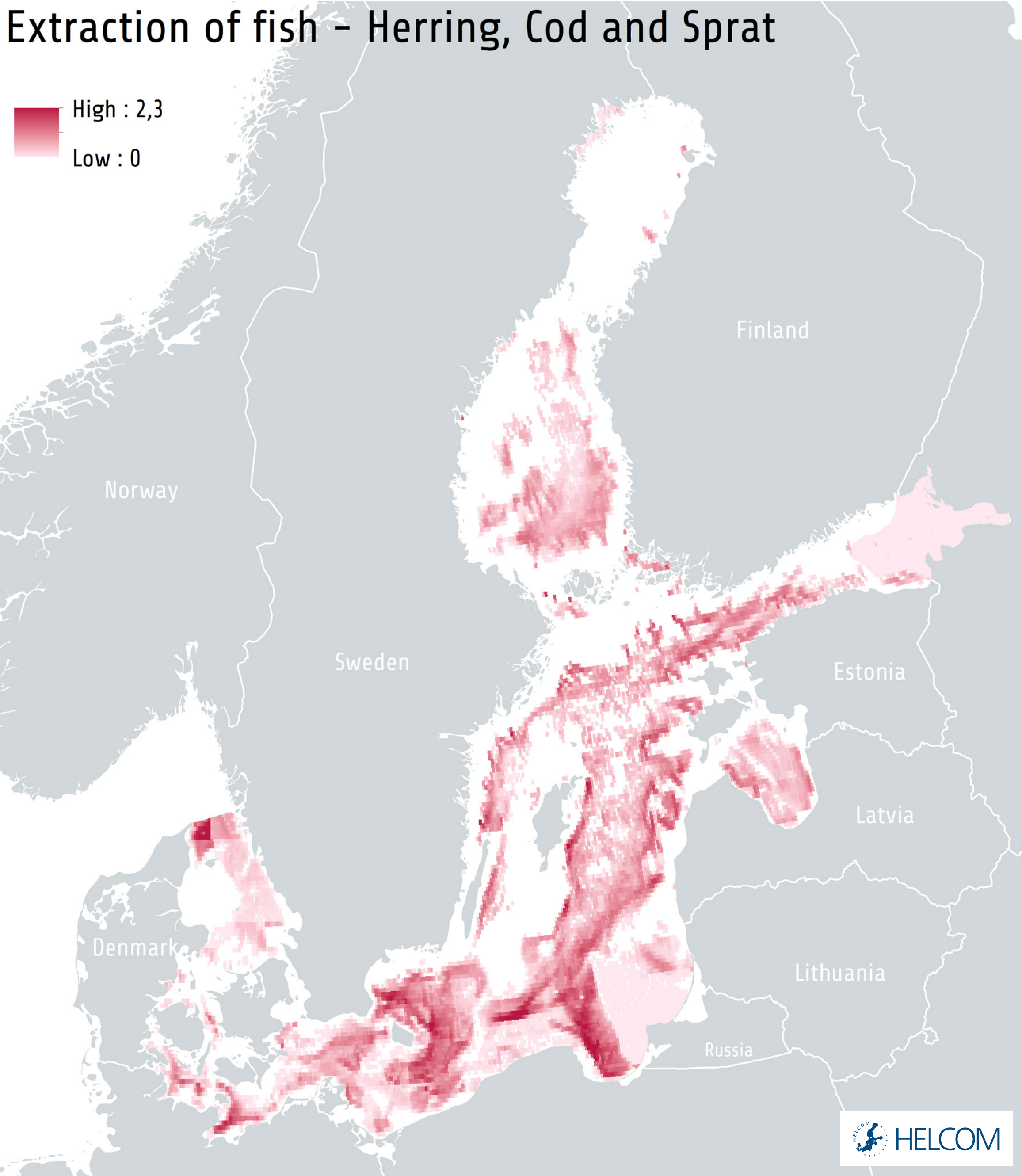

Figure 4.22. Spatial distribution and intensity of fishing efforts for the three main commercial fish species in the Baltic Sea, namely herring, sprat and cod, using all gear types, in 2016–2021. The layer is based on data on commercial fishing during 2016–2020, available at the spatial scale of ICES statistical rectangles from the EU Joint Research Centre's data collection framework for fisheries data, for Contracting Parties which are part of the European Union. Source: HELCOM 2023e.

The age/size structure of fish was evaluated for changes over time without applying threshold values. Three out of the fourteen stocks that could be evaluated showed a decreasing age or size structure, namely Eastern Baltic cod, flounder in the Belt Seas and the Sound, and flounder east of Gotland and in the Gulf of Gdansk. The other stocks showed an increase or no significant trend over time, though in several cases this reflected the fact that they were constantly at low levels.

The pelagic species sprat (*Sprattus sprattus*) and herring (*Clupea harengus*) clearly make up the largest share of landings in the Baltic Sea, contributing to over 80% of the landings by weight. Pelagic commercial fishery is widespread, while demersal open sea fish are mainly caught in the southern parts of the region (ICES 2022, Figure 4.22). Fisheries for other species mainly occur along the coast. In some areas, the volume of landings in recreational and subsistence fisheries is higher than in commercial fisheries, especially for freshwater species, such as pikeperch, pike, perch and whitefish along the coast. The main target species for recreational and subsistence fisheries varies between sub-basins, depending on which species occur in the area (HELCOM 2020c).

The total value of landings has been constant or slowly declining in Baltic Sea countries and has decreased in recent years (Chapter 2).

Impacts of fish extraction in the Baltic Sea ecosystem

Overfishing has been connected with declined fish stocks and a worsened age and size structure of several fish stocks in the Baltic Sea as well as adjacent seas (ICES 2022, HELCOM 2023a, HELCOM 2023d, Cardinale *et al.* 2009, Eero *et al.* 2008, Svedäng and Hornborg 2014).

Changes in fish stocks have also been attributed to changes in overall species composition, leading to structural changes in the food web (Chapter 3, HELCOM 2023a, Möllmann *et al.* 2009, Casini *et al.* 2008, Tomczak *et al.* 2012, Blenckner *et al.* 2015, Casini *et al.* 2012, Eriksson *et al.* 2011, Olsson *et al.* 2015, Tomczak *et al.* 2016, Eklöf *et al.* 2020, Einberg *et al.* 2019, Scotti *et al.*, 2022a).

Unintentional by-catch of birds and mammals, as well as the effects of physical disturbance from fishing gear, are addressed in the sections below.

Sources of pressure from fishing

Fish are a key source of livelihood for humans, but overfishing is connected with detrimental effects on the marine environment and on longer-term prosperity.

The main part of commercial catches in the Baltic Sea are from stocks that are managed internationally within the framework of the EU Common Fisheries Policy. The International Council for the Exploration of the Sea (ICES) provides advice on stock status and fishing opportunities for internationally managed fish stocks (e.g. ICES 2022). Alignment with scientific advice is vital for decisions on fishing quotas to be in line with the environmental, ecological and social sustainability needs of the marine environment. However, the scientific advice has generally not been followed by policymakers in earlier years (HELCOM 2023d). Although countries appear to recognize the hazards of exceeding the biological limits for fish extraction, there seem to be certain reasons to maintain some fish quotas above scientifically advised levels. This likely highlights short-term conflicts between environmental and socioeconomic concerns, though there has been a reduction in the difference between total allowable catches and scientific advice over the past twenty years (Figure 56). Coastal fisheries are managed nationally, where management implementation typically faces challenges related to data deficiency on the spatial and temporal patterns of commercial as well as recreational fisheries. Insufficient regulation or compliance issues may also commonly occur (HELCOM 2020c).

Regulations and needs

The Baltic Sea Action Plan stresses that achieving good environmental status for the Baltic Sea will require major effort and transformational changes in all sectors of the economy affecting the sea, including fisheries.

A central target of the UN Sustainable Development Goals, embraced by HELCOM, is to effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing, and destructive fishing practices, as well as to implement science-based management plans and to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yields as determined by their biological characteristics (SDG 14.4).

Ensuring the implementation of fisheries management in line with scientific advice is vital for the long-term sustainable use of marine resources. Furthermore, several stocks in the Baltic Sea are currently in need of dedicated restoration efforts after long-term deterioration.

Climate change considerations and ecosystem changes leading to changes in food web processes and productivity are expected to affect the productivity of fish stocks and the distribution ranges of fish stocks, and to create new demands for ecosystem-based fisheries advice (ICES 2023).

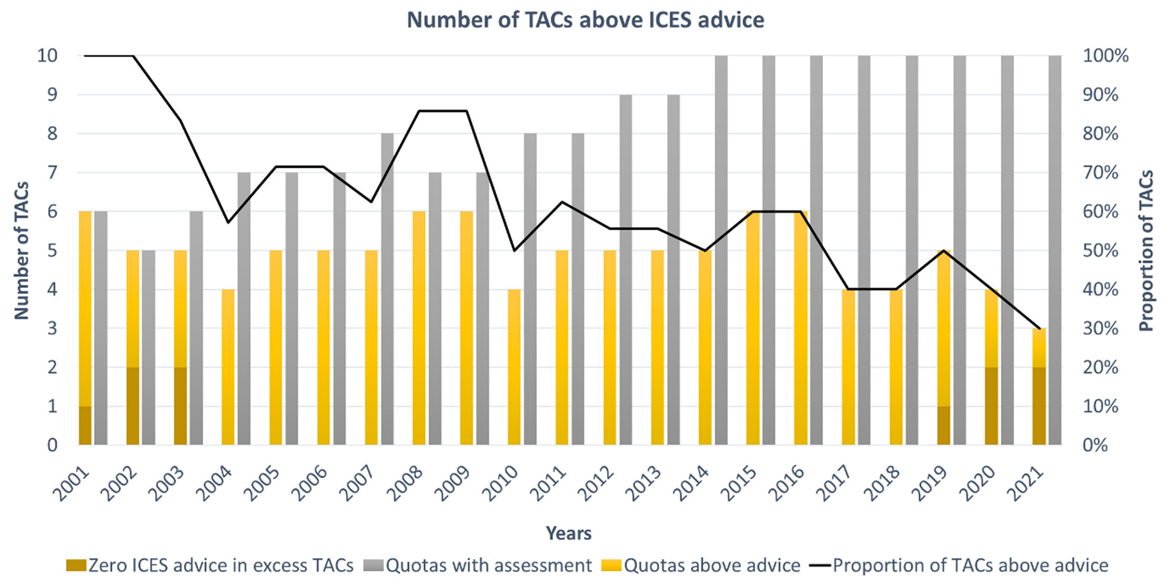

Figure 4.23. Number of cases with Total Allowable Catch (TAC) set above ICES advice for internationally managed fish stocks in the Baltic Sea during 2001–2021. The chart does not include data from Russia. The stocks included are salmon (ICES subdivisions 22–31, subdivision 32), cod (subdivisions 22–24, subdivisions 25–32), herring (subdivision 28.1, subdivisions 25–27, 28.2, 29, 32, subdivisions 30–31, subdivisions 22–24), plaice (subdivisions 22–32), and sprat (subdivisions 22–32). Cases in which ICES has advised zero catches (cod subdivisions 24–32 and herring subdivisions 22–24) are highlighted in dark yellow. Source: HELCOM 2023d.

4.3.2 Unintentional by-catches

Fisheries by-catches have an impact on pelagic- and benthic-feeding waterbirds in the Baltic Sea, as well as marine mammals (Box 4.8). The impacts occur widely, although they can differ between species groups (depending on their feeding mode, for example). Based on available data, the highest impacts are generally in the Great Belt, the Sound, the Bornholm Basin and the Arkona Basin, reflecting both higher fisheries activity in these areas and access to better data on by-catch. However, by-catch affects animals in all parts of the region. The problem of by-catch is particularly important for species with poor conservation status , such as the harbour porpoise in the Baltic Sea.

For pelagic- and benthic-feeding waterbirds, all sub-basins from the Kattegat to the Eastern Gotland Basin fail to achieve good status with regard to by-catch. The impacts of by-catch are also too high on all marine mammal populations. For more results on the integrated status assessments of biodiversity including the by-catch aspect, please see Chapter 9 in HELCOM (2023a).

A quantitative assessment of by-catches has not been carried out before in HELCOM, but available evidence suggests that the status is unchanged since the previous assessment period.

The impacts of unintentional by-catch in the ecosystem

Unintentional by-catch occurs widely in the Baltic Sea, but the risk varies for different species of waterbirds and marine mammals, depending on their feeding behaviour. There are also seasonal trends that influence by-catch levels. For example, fish-eating birds, such as divers, grebes, mergansers, auks and cormorants, and benthic-feeding birds (ducks) are highly susceptible to entanglement and drowning in fishing gear. However, due to a lack of monitoring, it is not possible to quantify the consequences for either bird or marine mammal populations.

BOX 4.8.

What are unintentional by-catches?

Unintentional by-catch in fishing gear occurs in many fisheries worldwide and is among the most significant causes of human-induced mortality in a large number of marine mammal and waterbird species (Read et al. 2006, Lewison et al. 2014, Dias et al. 2019). Mammals and waterbirds easily become entangled in various types of fishing gear and subsequently die by drowning. Scientific studies have indicated that the number of waterbirds actually caught in by-catch in the Baltic Sea is considerably higher than number stated in official reports (Morkūnas et al. 2022).

Minimizing by-catch of marine mammals and water birds is included in the management objective:

— **human-induced mortality, including hunting, fishing, and incidental by-catch, does not threaten the viability of marine life" in the Baltic Sea Action Plan.**

Sources of unintentional by-catch

Gillnets and fish traps in commercial and recreational fisheries are the main causes of by-catch of marine mammals and waterbirds in the Baltic Sea, but by-catch also occurs in trawls (Figure 4.24). By-catch of waterbirds is also common in longline fishing, but this gear is not widely used in the Baltic Sea. Gillnets are particularly problematic, as they are nearly invisible to birds, which become entangled when they are diving for food. Estimates are uncertain, but studies on birds have shown that gillnet fishery causes the death of up to 100,000-200,000 birds annually in the Baltic Sea and North Sea combined (Žydelis *et al.* 2009).

For birds, the by-catch problem is more severe when gillnet fishery is practised in areas with high concentrations of resting, moulting or wintering seabirds. In the Baltic Sea, gillnet fishery often takes place in shallow coastal areas or on shallow offshore grounds, which are also the most important habitats for birds. The overlap of gillnet fishing and high concentrations of birds usually occurs only during certain periods of the year, such as the wintering, autumn and spring migration or moulting time (Zydelis *et al.* 2009, Sonntag *et al.* 2012). In such instances, the risk and occurrence of by-catch is high.

Marine mammals are also impacted and data limitations are problematic. In the Belt Sea, estimates of harbour porpoise by-catch are in the high hundreds per year (Glemarec *et al.* 2022), and available data for the Baltic Proper population indicate that on average three animals are caught in by-catch per year (HELCOM 2023i). In both cases, these values exceed the relevant threshold values. The threshold value is set to zero for the highly sensitive Baltic Proper population, reflecting its Critically Endangered status. The quality of data from direct monitoring of by-catch is also a limiting factor for seals. However, available estimates commonly indicate that by-catches exceed threshold values; for example, grey seals are caught in by-catch by the thousands (Vanhatalo *et al.* 2014).

Regulations and needs

HELCOM countries actively work to share information on topics related to by-catch, identify additional measures and agree on joint actions to reduce by-catch. Potential measures include changes in what fishing gears are used and temporal or permanent spatial closures of fisheries using certain gear, as well as the use of acoustic deterrents.

Climate change could affect the risk of by-catch in certain areas, as the spatial distribution of fish can be expected to change with a warming climate, and the fisheries, as well as the waterbirds and mammals feeding on the fish, would be expected to follow.

Figure 4.24. Fish-eating birds, such as mergansers, are susceptible to entaglement and drowning in fishing gear.

4.3.3 Hunting of birds and mammals

Hunting of marine mammals is forbidden in Germany, Latvia, Lithuania and Poland. Control hunting of seals is allowed in Estonia (only grey seals), Finland and Sweden. In Denmark, regulation of seals is allowed with the purpose to mitigate conflicts with local fisheries (Figure 4.25, Box 4.9, HELCOM 2023a).

The large majority of grey seal hunting occurs in Sweden and Finland. The total number allowed has increased from around 500 seals in the early 2000s to around 3,500 in 2022. A total of 6,598 grey seals were hunted during 2016-2021.

Hunting of ringed seals has also increased, taking place only in the Bothnian Bay management unit. A total of 2,463 ringed seals were hunted during 2016-2021.

In total, 1,690 harbour seals were hunted during 2016-2021 on the west coast of Sweden and in Denmark.

Most of the hunted waterbirds are sea ducks. For the common eider (*Somateria mollissima*), hunting bag statistics give a total of 135,656 individuals across the Baltic Sea during 2016-2021, with hunting taking place in Denmark, Estonia, Finland and Sweden (Figure 4.26). Other waterbird species with relatively large hunting bags are the common long-tailed duck (*Clangula hyemalis*), common goldeneye (*Bucephala clangula*) and common scooter (*Melanitta nigra*), coming to 31,422, 33,098 and 13,222 individuals, respectively.

Pest control hunting of cormorants occurs in Estonia, Finland and Sweden and is estimated to have numbered 38,716 cormorants in total during 2016-2021.

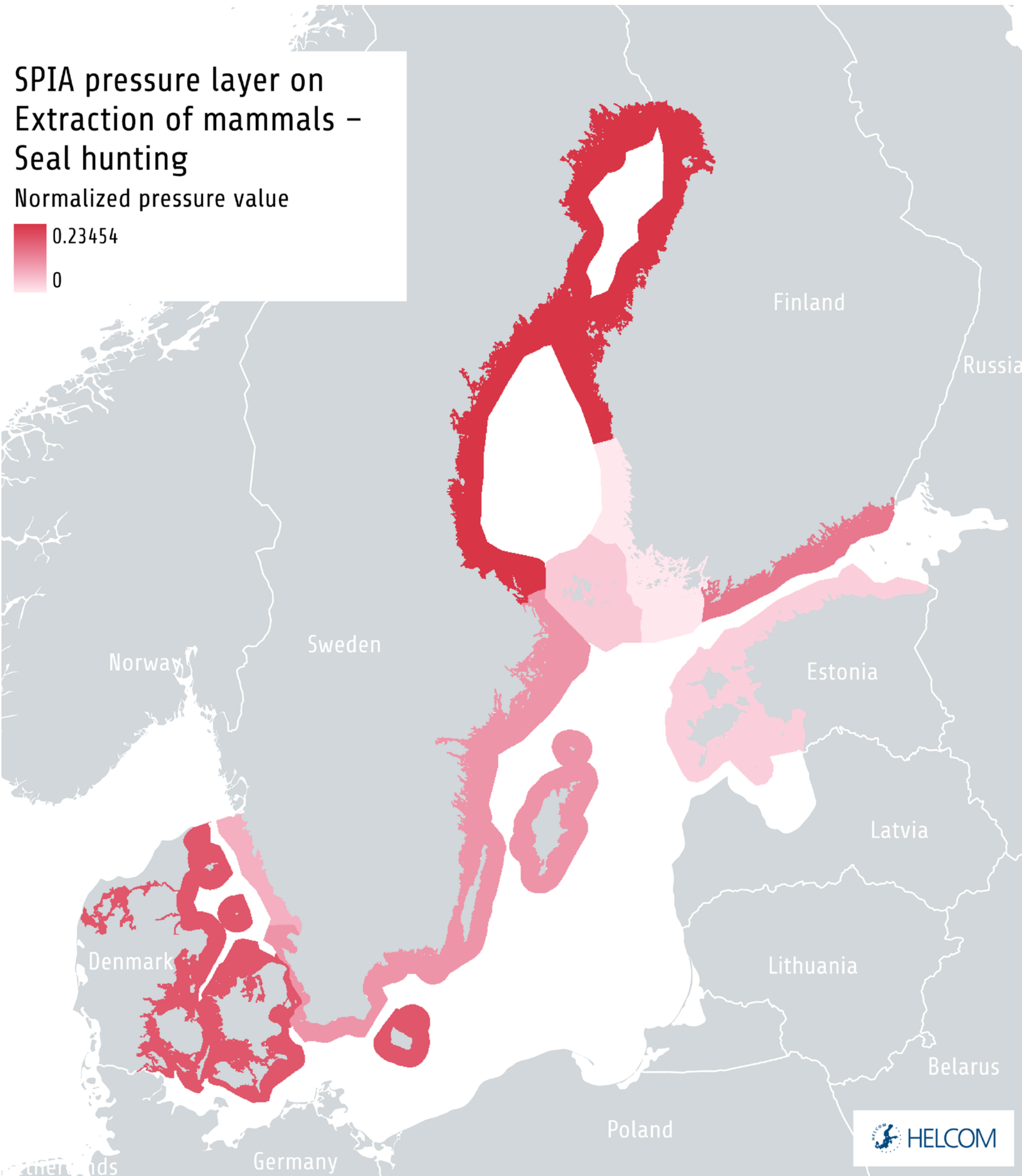

Figure 4.25. Spatial distribution and relative intensity of seal hunting in the Baltic Sea during 2016–2021. Source: HELCOM 2023e.

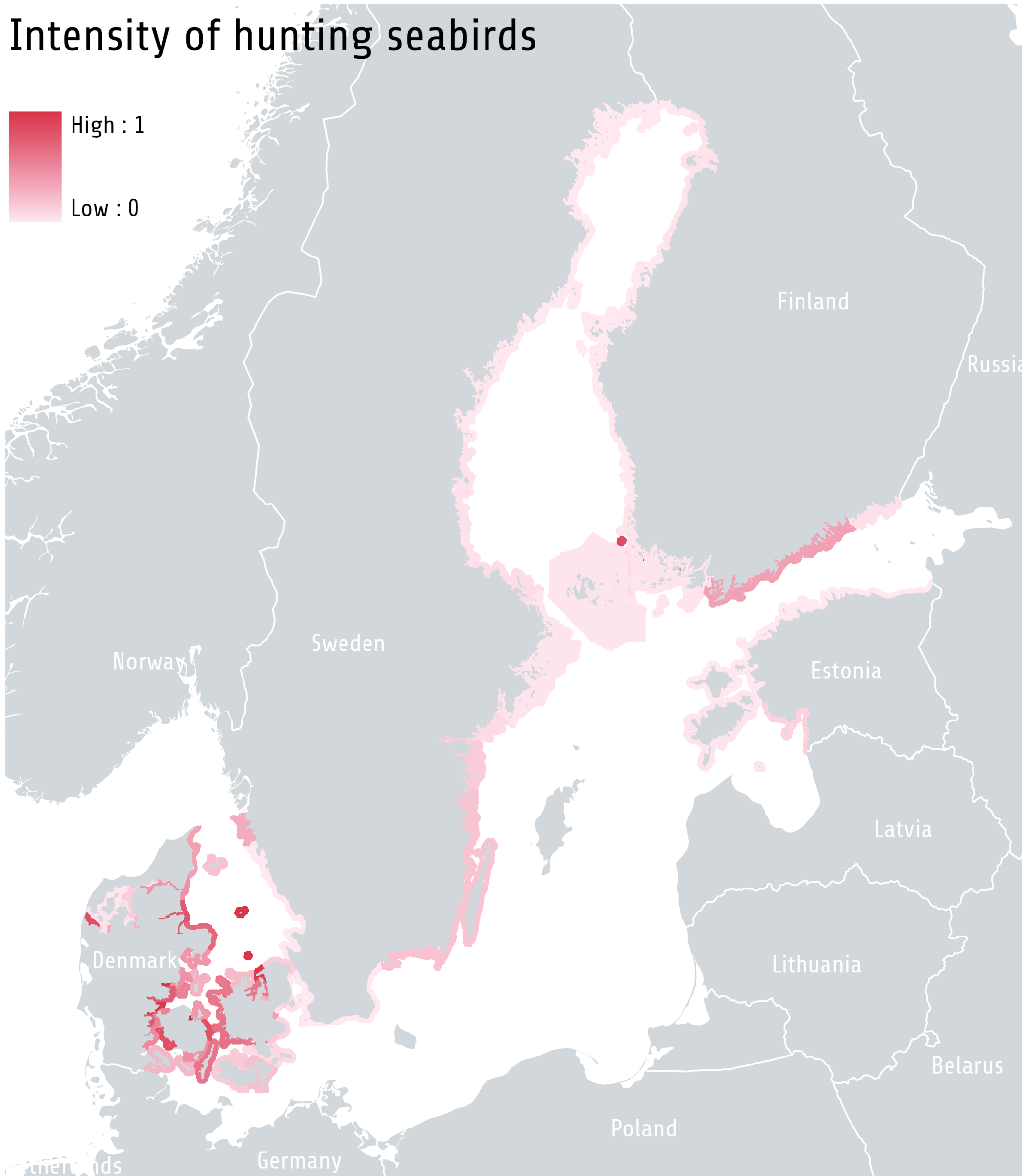

Figure 4.26. Spatial distribution and relative intensity of waterbird hunting in the Baltic Sea during 2016–2021. Total numbers include both game hunting for game and control hunting. Source: HELCOM 2023e.

Impacts of hunting in the Baltic Sea ecosystem

In addition to removing individuals from the population, hunting can affect the behaviour of a species through biological disturbance. The effects of hunting on the behaviour of grey seals were observed in the Stockholm archipelago in Sweden. The number of grey seals observed in moulting time surveys dropped dramatically in recent years, along with increased hunting in the area. At the same time, increased numbers were observed in the archipelago of south-west Finland, suggesting a range shift. However, this change does not fully explain the decrease in the Stockholm archipelago and other explanations may exist. For example, if hunting leads to changes in the spatial occurrence, this canalso increase other risks, such as risks of unintentional by-catches.

Key sources of the pressure

Licensed hunting of grey seals was introduced in Sweden in 2020, and grey seal hunting has been run by regional quota in Finland since 2014. Estonia has licensed grey seal hunting since 2015, but the annual hunting quota in Estonia is comparatively low (between 37-55 animals).

The combined annual quota for ringed seals in Sweden and Finland is around 700 individuals.

Sweden has allowed protective hunting of harbour seals in relation to fisheries since the early 2000s, and licensed hunting was introduced in 2022, with a current quota of 730. No hunting of the Kalmarsund harbour seal population is allowed.

BOX 4.9.

Hunting of marine mammals in the Baltic Sea

Hunting has historically been a major pressure on marine mammals in the Baltic Sea. All seal species in the Baltic Sea were severely reduced at the beginning of the twentieth century as the result of a coordinated international campaign to exterminate seals (Anon 1895). Bounty systems were used in Denmark, Finland and Sweden over the period 1889-1912, and very detailed bounty statistics provide detailed information on the hunting pressure.

Hunting resulted in the local extinction of grey seal and harbour seal in Germany and Poland in 1912 and of grey seals from the Kattegat by the 1930s. Baltic grey seals were reduced to about 20,000 in the 1940s (Harding & Härkönen 1999). Harbour seals went down to around 2,500 in the Kattegat and Skagerrak in the late 1970s, and the hunting pressure caused a rapid decline in the Kalmarsund harbour seal population. Only around 200 seals remained in the Kalmarsund harbour seal population in the 1960s (Heide-Jørgensen & Härkönen 1988; Härkönen & Isakson 2011). Hunting of seals became prohibited in the 1960s and 1970s.

Historically there have also been large catches of harbour porpoises in the Baltic region, with around 2,000 individuals taken annually in Danish waters in the late nineteenth century and possibly larger catches in the Baltic Proper (Kinze 1995).

4.3.4 Seafloor loss and disturbance

The seafloor is negatively affected by several human activities, including bottom trawling fishery, mariculture, extraction and disposal of sediments (e. g. dredging and dumping) and shipping, as well as coastal protection and the construction and operation of pipelines and cables, platforms and wind farms. Assessing single pressures in isolation does not provide representative results about seafloor integrity because multiple pressures typically act on the environment simultaneously. For the purposes of the holistic assessment, information about activities known to result in physical pressures on the environment was combined, providing an overview of the spatial distribution and intensity of disturbances to seabed habitats (Figure 4.27) and their loss (Figure 4.28).

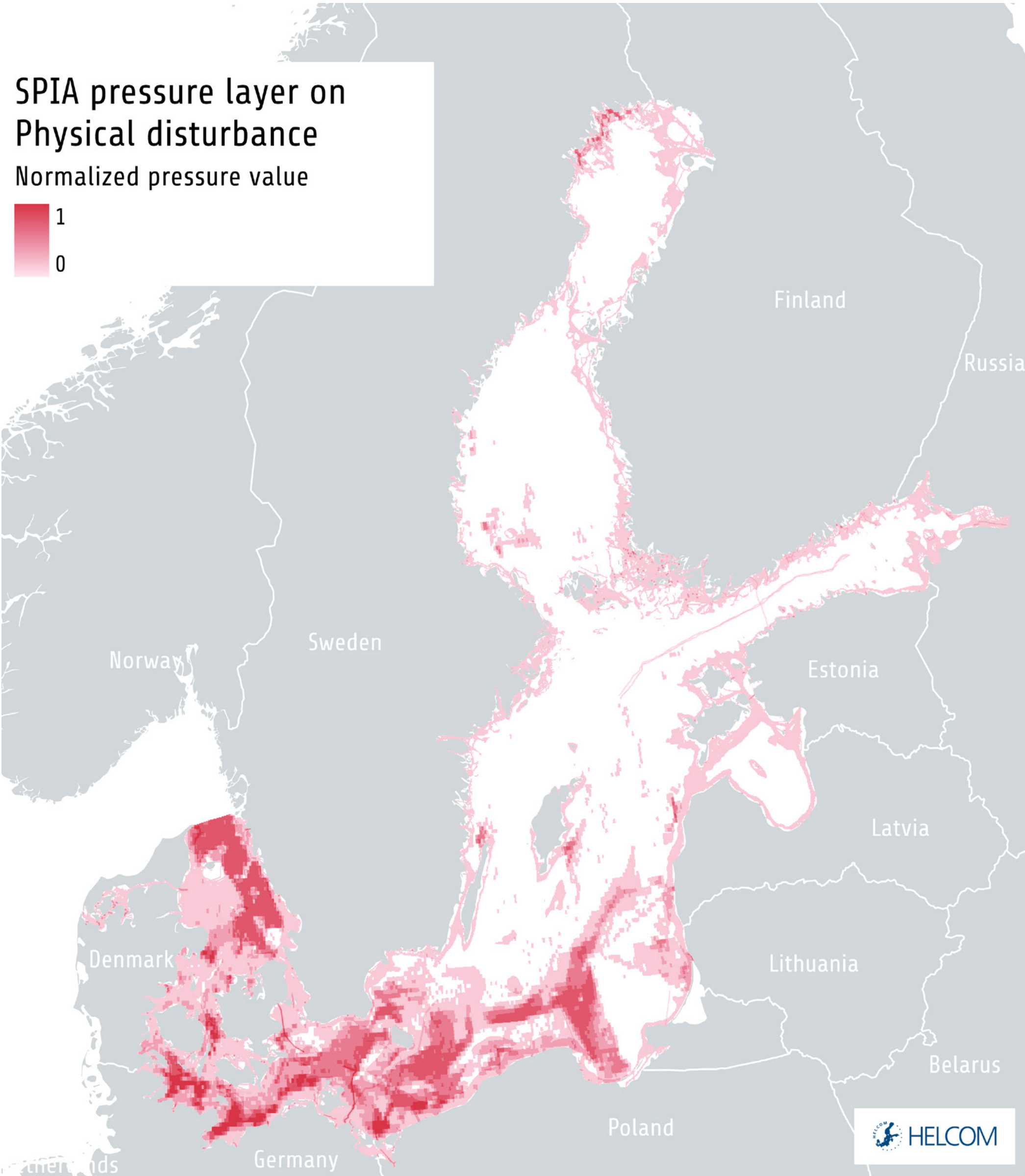

Figure 4.27. Assessment results from the assessment of seafloor disturbance. Source: HELCOM 2023d.

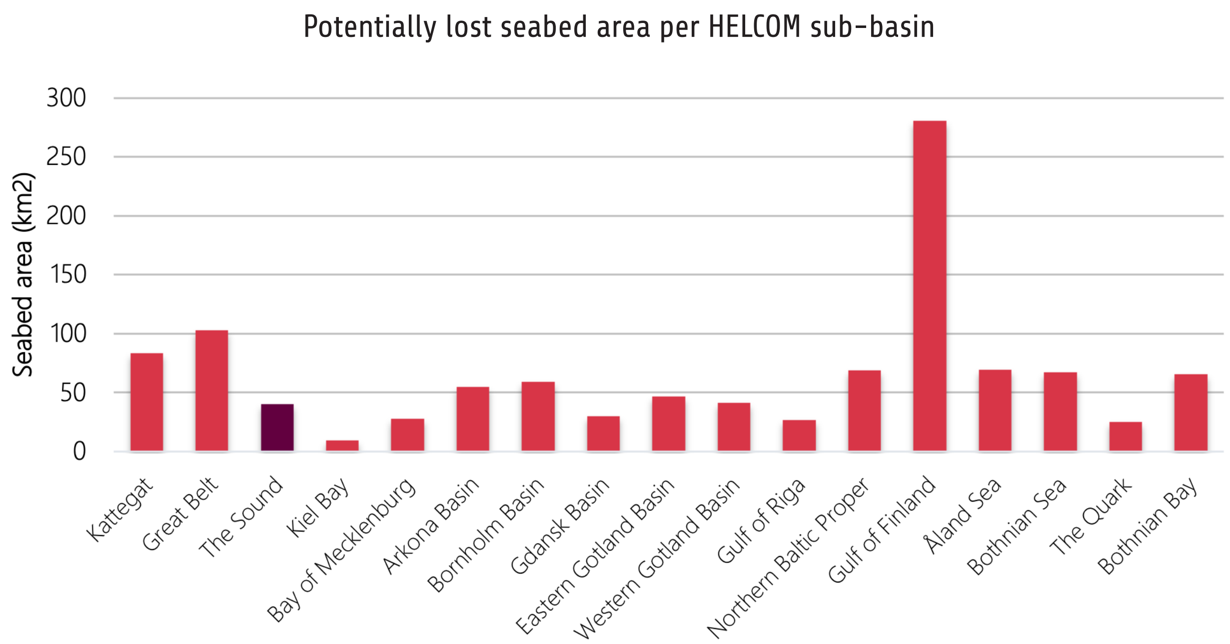

Figure 4.28. Estimated seabed area potentially lost due to human activity for each Baltic Sea sub-basin, given as square kilometres. Values were estimated from spatial data on human activities identified as causing physical loss. Dark red indicates sub-basins where up to 1–10% of the total area could be lost. For the other sub-basins, the potentially lost seabed area was estimated to cover less than 1% of the total area. Source: HELCOM 2023d.

While seabed disturbance is more widespread, less than 1% of the total area of the Baltic Sea is estimated to suffer from potential long-term physical loss of the seabed (Box 4.10). When comparing estimates for different sub-basins, the Sound has the highest potential loss relative to its area, estimated to be above 4% (Figure 4.28). In the majority of the sub-basins, the estimated potential loss of seabed area is clearly below 1%, based on data reported for the assessment period.

There are some differences between the loss values generated under the SPIA assessment (HELCOM 2023e) and the benthic habitat integration process (HELCOM 2023a) because of differences in the application of certain buffer areas or spatial interpretation of structures (e.g. harbours). Although these differences are minor on the scale of a subbasin, further harmonization to eliminate discrepancies is needed.

BOX 4.10.

What is physical loss and disturbance, and how is the status of seabeds assessed?

Physical disturbance is defined as a change to the seabed that can be reverted if the activity that causes the disturbance ceases, while physical loss is defined as a permanent change of seabed substrate or morphology. In this context, "loss" implies that the change to the seabed has lasted (or is expected to last) for more than twelve years (EC 2017a).

The Baltic Sea Action plan addresses seafloor loss and disturbance in the ecological objective

— natural distribution, occurrence and quality of habitats and associated communities.

In HELCOM, the indicator "Cumulative impact from physical pressures on benthic biotopes" (CumI) evaluates the aggregated potential impact from physical pressures attributed to several human activities taken together, using a spatial categorical predictive approach (HELCOM 2023a, 2023g). Activities considered in the current evaluation are bottom trawling, aquaculture, extraction, dredging and dumping, coastal protection, shipping, and the construction and operation of pipelines and cables, platforms and wind farms.

An overall evaluation of the condition of benthic habitats is derived based on an integration of the relatively few assessment components of relevance to benthic habitats (currently CumI, State of the soft-bottom macrofauna community, and oxygen). This makes it possible to apply the spatial assessment at the level of broad-scale benthic habitats (as developed under EUSeamap 2021 for the Marine Strategy Framework Directive).

By combining information about the distribution of physical pressures and of the underlying benthic habitats, and their sensitivity to the pressures, it is possible to estimate the potential environmental impact from physical pressures. This evaluation indicated that the risk for cumulative impacts from physical pressures is clearly higher in the southern Baltic Sea and in the Kattegat than in other parts of the Baltic Sea region (Figure 4.29). Pressures distributed over a wide area, such as fishing using bottom trawling, contribute most to the risk for impact. In archipelago areas, and especially in coastal fairways, erosion from shipping can have a high impact on seafloor sediments. Coastal protection is constrained to very narrow stretches or points in the Baltic Sea region.

Sources and impacts of seafloor loss and disturbance in the Baltic Sea ecosystem

Physical loss and disturbance have direct effects on the affected habitat. Physical disturbance of the seafloor occurs when bottom-contacting fishing gear scrapes the surface of the seabed. During such activities, sediments are mobilised and dispersed. The gear can also reach deeper into the sediment, causing sub-surface abrasion. This temporary disturbance results in bottom-dwelling species being removed from the habitat or relocated (Dayton *et al.* 1995). It has a particularly strong impact on slow-growing sessile species, biogenic structure-forming organisms and rare or localised species, which may be eradicated. Since bottom trawling is typically repeated in the same location, even more resilient organisms may have little chance of recovery, leading to changes in species composition over time (Kaiser *et al.* 2006, Olsgaard *et al.* 2008). In addition, sediments are mobilised into the water and may be transported to other areas, causing smothering of other substrates or habitats or the release of hazardous substances that have been previously buried in the seabed (Jones 1992, Wikström *et al.* 2016). Other human activities leading to physical disturbance act in the same way. The severity of the impact depends on factors such as the depth of the disturbed sediment layer, the total area affected, whether the activity is repeated regularly and the sensitivity of species in the affected habitat.

The indicator for cumulative impact from physical pressures on benthic biotopes is structured around human activities known to impact on benthic biotopes through physical disturbance, especially those with a large spatial extent, such as bottom trawling. Activities causing more local disturbance include tourism, leisure activities and infrastructure. Activities resulting in physical loss are commonly linked with construction or infrastructure development, such as wind farms, port infrastructure or coastal defence. While the actual footprint of such structures may be small, their presence can also alter conditions in the surrounding areas and generate localised disturbance. It is also possible thatactivities catalyse functional loss, if the resident biota are unable to flourish.

Regulations and needs

HELCOM countries have agreed to jointly develop a common approach to address and minimize the loss and disturbance of seabed habitats caused by human activities wherever possible, including through the identification of further measures to reduce adverse effects.

The upcoming EU restoration law is expected to require the implementation of measures to reduce adverse effect and restore impacted habitats.

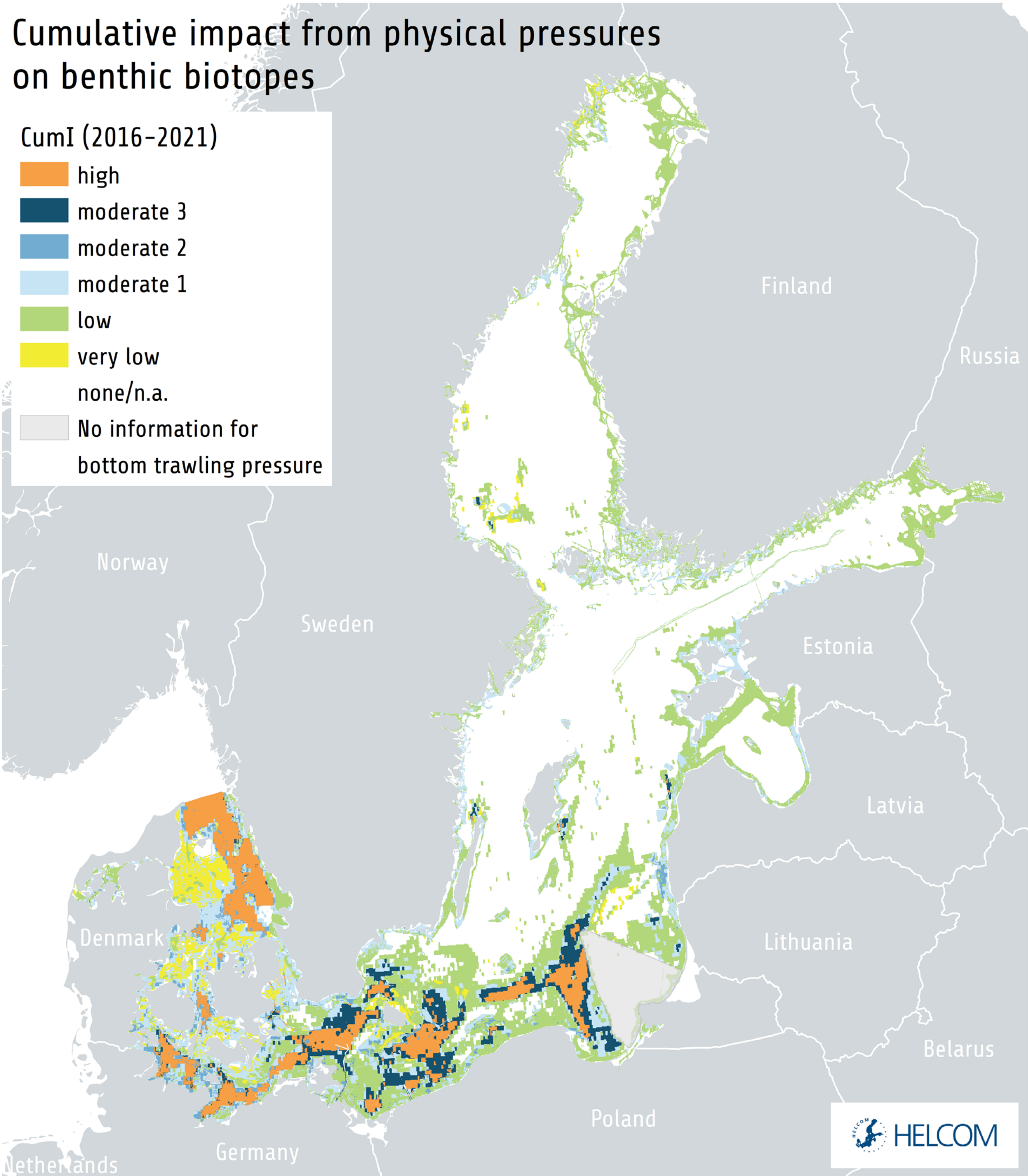

Figure 4.29. Evaluation result of the indicator for cumulative impacts of physical pressures on benthic biotopes in the Baltic Sea, based on reported data for 2016-2021. The map indicates the combined potential impact of physical disturbance (see Box 15). Information on physical pressures from bottom trawling fishery is missing for the area off the coast of Oblast Kaliningrad, marked with a semi-transparent grey triangle. White areas within the Baltic Sea area represent regions with no impact . Source: HELCOM 2023a.

4.4. Protection and restoration

While reducing or preventing harmful inputs and minimizing pressures from human activities at sea are of key importance to ensure the broad recovery of species and habitats in the Baltic Sea, spatial protection supports biodiversity by ensuring sustainable limits to human exploitation or activities in defined areas.

Marine protected areas are the most common form of spatial protection in the Baltic Sea. Other measures that contribute to effective area-based conservation can also be included in the concept of spatial protection.

However, in cases where the natural ecosystem has been degraded, damaged or destroyed, restoration measures may be needed to assist recovery, and these are increasingly being used in HELCOM countries (Box 4.11).

Figure 4.30. Marine protected areas are spatially defined areas that are selected for protection because they can be particularly useful to safeguard marine ecosystems, processes, functions, habitats and species.
© Juuso Haapaniemi