4.2 Baltic Sea ecoregion – Fisheries overview

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Executive summary

The commercial fisheries in the Baltic Sea target only a few stocks. The pelagic fisheries, which account for the largest catches (by weight) in the region, are the mid-water trawl fisheries for sprat and herring. The most important demersal fisheries are the bottom-trawl fisheries for cod and flatfish. The demersal fisheries are concentrated in the south and west of the Baltic Sea, while the pelagic fisheries are more widespread. Basin-wide, commercial fishing effort has declined in recent years. Recreational fisheries in the Baltic catch a diversity of species, with cod and salmon accounting for the largest number of landings. Most of the Baltic Sea fish stocks with reference points are fished at or below F_{MSY}. Multispecies analysis indicates that there is a trade-off between fishing cod or herring and sprat in the central Baltic Sea. Patterns of seabed habitat disturbance reflect the distribution of bottom-trawl fishing effort. A large and, for some species, probably unsustainable bycatch of seabirds (greater scaup, common guillemot, and long-tailed duck) occurs at times in the gillnet fisheries; these fisheries also catch individuals of the critically endangered Baltic Proper harbour porpoise.

Introduction

The Baltic Sea is a shallow, semi-enclosed, brackish sea, characterized by vertical stratification of the water column (Figure 1). Salty, well-oxygenated water from the North Sea occasionally enters the Baltic Sea through the Belt Seas and propagates into the deeper areas, while freshwater flows exit at the surface. Stratification limits the oxygen from reaching the deeper waters, so the oxygen content of the bottom water depends on surface oxygen consumption and the inflows of North Sea water. Due to these hydrological characteristics, the basin has a limited diversity of fish species, dominated by marine species in the southwestern areas and a combination of marine and freshwater species in the northeastern areas (subdivisions 28.1, 29-32). Fisheries in the Baltic Sea are focused on a few major species. Commonly referred to areas in Baltic Sea are defined as follows: Baltic Proper (Subdivisions 24-29, excluding 28.1), and Central Baltic (Subdivisions 25-29).

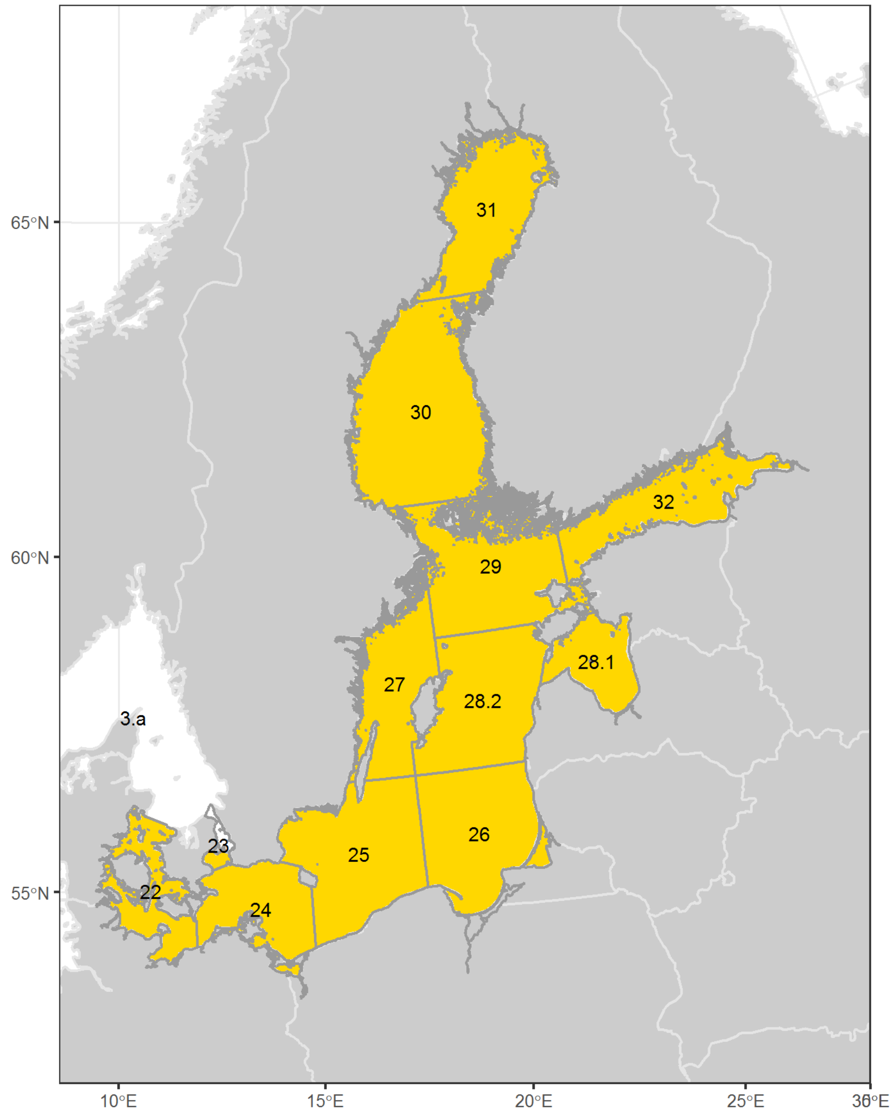


Figure 1 The Baltic Sea ecoregion (highlighted in yellow) and ICES statistical areas. ICES Subdivision 23 is usually defined as part of the Greater North Sea ecoregion, but to be consistent with the current fisheries management regime it is included in this overview.

The overview covers ICES Subarea 27.3, excluding Division 27.3.a (hereafter, the area prefixes are omitted), and provides:

- a short description of each of the national fishing fleets in the ecoregion, including their commercial and recreational fisheries and fishing gears and patterns;
- a summary of the status of the fisheries resources and the level of exploitation relative to agreed objectives and reference points;
- an examination of mixed-fisheries considerations of relevance to the management of the fisheries; and
- an evaluation of impacts of fishing gear on the ecosystem in terms of physical contact on subsurface and bottom habitats, and on the bycatch of protected species.

Who is fishing

Fishing vessels from nine nations operate in the Baltic Sea, with the highest number of large vessels (> 12 m) coming from Sweden, Denmark, and Poland. Total finfish landings from the Baltic Sea peaked in the mid-1970s and again in the mid-1990s, corresponding to peaks in the abundance of cod and sprat stocks respectively. The proportion of the total annual landings caught by each country has varied little over time, except for the redistribution of catches by former USSR countries (Figure 2). Total fishing effort has declined since 2003 (Figure 3). The following paragraphs highlight features of the fleets and fisheries of each country, but are not exhaustive descriptions.

Denmark

The Danish fleet comprises close to 350 vessels, divided into offshore fisheries (approximately 100 vessels 8–12 m and 80 vessels >12 m) and coastal fisheries (approximately 150 vessels). The large vessel offshore fisheries target (a) sprat and herring in the northern Baltic Sea using small-meshed pelagic trawls and (b) cod and plaice in the southwestern Baltic fisheries using demersal trawls; over the last 2 years, however, the cod fishery has been decreased substantially. In the western Baltic Sea a flatfish fishery exists targeting plaice; it also catches turbot, dab, flounder, and brill. The coastal fisheries target species such as eel, flatfish, and cod using mainly trapnets, poundnets, and gillnets; they occur off all coasts and in the Belt Sea area. Recreational fisheries target different species depending on the season, with cod, salmon, and trout being among the most important species. The main recreational fishing area for cod is the Sound (Subdivision 23), while for salmon most recreational fishing takes place from the island of Bornholm in subdivisions 24 and 25.

Estonia

The active offshore fleet comprises around 25–30 fishing vessels of 18–42 m, while the coastal fishery consists of several hundred small boats of <12 m. The pelagic fleet consists mostly of stern trawlers, targeting herring and sprat in subdivisions 28.1, 28.2, 29, and 32. Trawlers also occasionally catch cod in subdivisions 25 and 26. About 25–30% of the herring catch is taken by coastal fisheries. Main areas of coastal herring fishery are the Gulf of Riga (Subdivision 28.1) and the Gulf of Finland (Subdivision 32), where trapnets and poundnets are used. Flounder is also taken (using Danish seines and gillnets) in the coastal fisheries in the Gulf of Riga and subdivisions 29 and 32. Recreational fisheries primarily target perch, pikeperch, flounder, and whitefish, mainly in the Gulf of Riga.

Finland

The fleet comprises 3352 vessels, of which about 1300 vessels are actively used in the fishery. The vast majority of the vessels are <10 m and operate in coastal fisheries. The offshore fleet is composed of 47 vessels >10 m in the Baltic main basin, the Archipelago Sea, the Gulf of Bothnia, and the Gulf of Finland; it mainly targets Baltic herring stocks (with sprat taken mainly as bycatch) with pelagic trawls. The coastal fisheries occur on all parts of the coast using trapnets, fykenets, and gillnets; they catch salmon, European whitefish, pikeperch, perch, pike, vendace, burbot, smelt, and occasionally flounder. Recreational fisheries target mainly perch, pike, pikeperch, European whitefish, bream, and herring using gillnets, rods, fish traps, and fykenets along the coast of Gulf of Finland as well as in in the Archipelago Sea and Gulf of Bothnia.

Germany

The German commercial fleet in the Baltic Sea consists of about 60 trawlers and larger (>10 m total length) polyvalent vessels, and about 650 vessels using exclusively passive gear (<12 m total length). The German herring fleet in the Baltic Sea, where all catches are taken in a directed fishery, consists of a coastal fleet with mostly undecked boats (rowing/motor boats ≤12 m) and a cutter fleet with decked vessels (total length 12–40 m). The German herring fishery in the Baltic Sea is conducted with gillnets, trapnets, and trawls; passive and active gear now share the landings about 70:30. Herring are fished mostly in the spring spawning season and in Subdivision 24. In the central Baltic Sea, almost all landings are taken by the trawl fishery. All catches of sprat are taken in a directed trawl fishery by cutters >18 m in length. Most sprat is caught in subdivisions 25–29 in the first quarter. Demersal species are caught with bottom trawls and passive gears, particularly with gillnets but also trammel nets. There are major targeted fisheries for cod and flounder (subdivisions 22, 24, 25; active, passive; year-round except peak summer months), plaice (Subdivision 22; active, passive; fourth/first quarter), dab (Subdivision 22, active; fourth quarter), turbot (Subdivision 24, gillnet, second quarter), and whiting (Subdivision 22, active, first/second quarter). Freshwater species are mainly targeted by passive gear fishers in coastal lagoons and river mouths. Recreational fisheries are carried out by an estimated 165 000 fishers, from all German shores and from boats (charter and private boats) mostly within 5 nautical miles (NM) of the coast; the main target species are cod, herring, trout, salmon, whiting, and flatfish.

Latvia

The fleet comprises around 55 registered offshore vessels (12–40 m) and 610 coastal vessels (<12 m). The offshore vessels target sprat in the Baltic main basin and herring in the Gulf of Riga using pelagic trawls; cod and flounder are targeted in subdivisions 25, 26, and 28 using demersal trawls. Since 2000, sprat and herring have accounted for 92% of the total annual landings. Most vessels in the coastal fleet are <5 m and target herring, round goby, flounder, smelt, salmon, sea trout, vimba bream, turbot, eelpout, and cod using fykenets, trapnets, and gillnets. Recreational fisheries occur on all coasts and target flounder, cod, perch, and round goby.

Lithuania

The Lithuanian fishing fleet in 2020 comprised 21 offshore vessels (>18 m) and 58 coastal vessels (< 12 m). The offshore fishing fleet uses pelagic and bottom trawls, with vessels switching between gears depending on target species, fishing conditions, and quota availability. The main target species are sprat, herring, cod, and flounder caught mainly in subdivisions 25, 26, and 28 as well as to a lesser extent in subdivisions 27 and 29. The coastal fisheries target herring, smelt, round goby, flounder, turbot, and cod using gillnets and trapnets within the Lithuanian coastal area of Subdivision 26. Recreational fisheries also occur in these waters and focus on cod, herring, salmon, and sea trout using rod-and-lines.

Poland

The fishing fleet consists of around 151 active offshore vessels (12–35 m) and approximately 649 coastal vessels (<12 m). The larger offshore vessels (>18.5 m) target sprat and herring using pelagic trawls for fishing sprat and herring, while smaller offshore vessels (12–18.5 m) target cod, flounder, and sandeel using bottom trawls. Fishing occurs mainly in subdivisions 24, 25, and 26 and these species form about 98% of the total annual landings. The coastal fisheries harvest salmon, trout, turbot, plaice, eel, roach, perch, bream, pikeperch, whiting, European whitefish, crucian carp, and garfish. Recreational fisheries mostly target cod and salmon, primarily along the central Polish coast and off the Hel Peninsula.

Russian Federation

The fishing fleet is composed of about 45 vessels divided into offshore fisheries (41 vessels by 25–31 m size class) and coastal fisheries (four vessels by 15–25 m size class). In subdivision 26, the vessels fleet MRTK targets sprat and herring while the demersal trawl fleet (about 27 m), targets cod and flounder. The gillnet fleet targets cod with flounder as bycatch. A poundnet fishery targeting herring occurs in the Vistula Lagoon. In the eastern part of the Gulf of Finland (Subdivision 32), the MRTK fleet operates mainly in the first, second, and fourth quarters and is orientated to herring. Recreational fisheries targeting cod, flounder, turbot, and salmon, goby, and others non-commercial species occur on all Russian coasts.

Sweden

The fleet is comprised of around 20 offshore vessels (around 10 vessels >40 m) and around 450 coastal vessels (the vast majority <12 m). The offshore fleet mostly targets herring and sprat using pelagic trawls in the main basin of the Baltic Sea, but also uses bottom trawls to fish for cod in the southern Baltic. Coastal fisheries use a mixture of gillnets, longlines, and fish traps to catch flatfish and cod as well as a variety of freshwater species (in the archipelagic areas) and herring, whitefish, and salmon in the Bothnian Bay. A coastal fishery using fykenets targets eel and other species along the southeastern coast. Along the eastern Swedish coast, trawl fisheries target herring and sprat. Recreational fisheries take place along the entire Baltic Sea coast and target marine and freshwater species including cod, salmon, pike, perch, and trout.

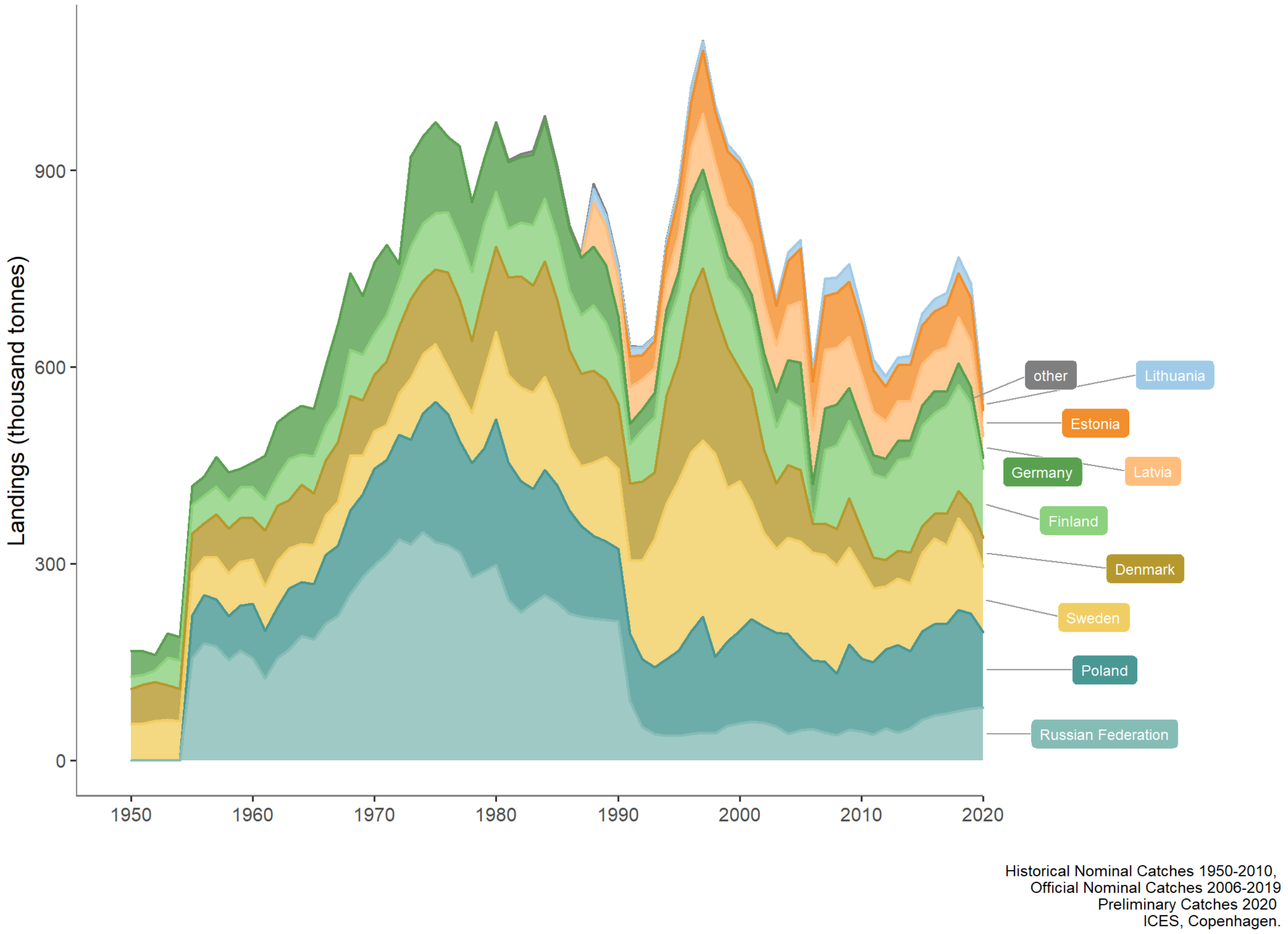


Figure 2 Landings (thousand tonnes) from the Baltic Sea in 1950–2020, by (current) country. The nine countries with the highest landings are displayed separately, and the remaining countries are aggregated and displayed as "other".

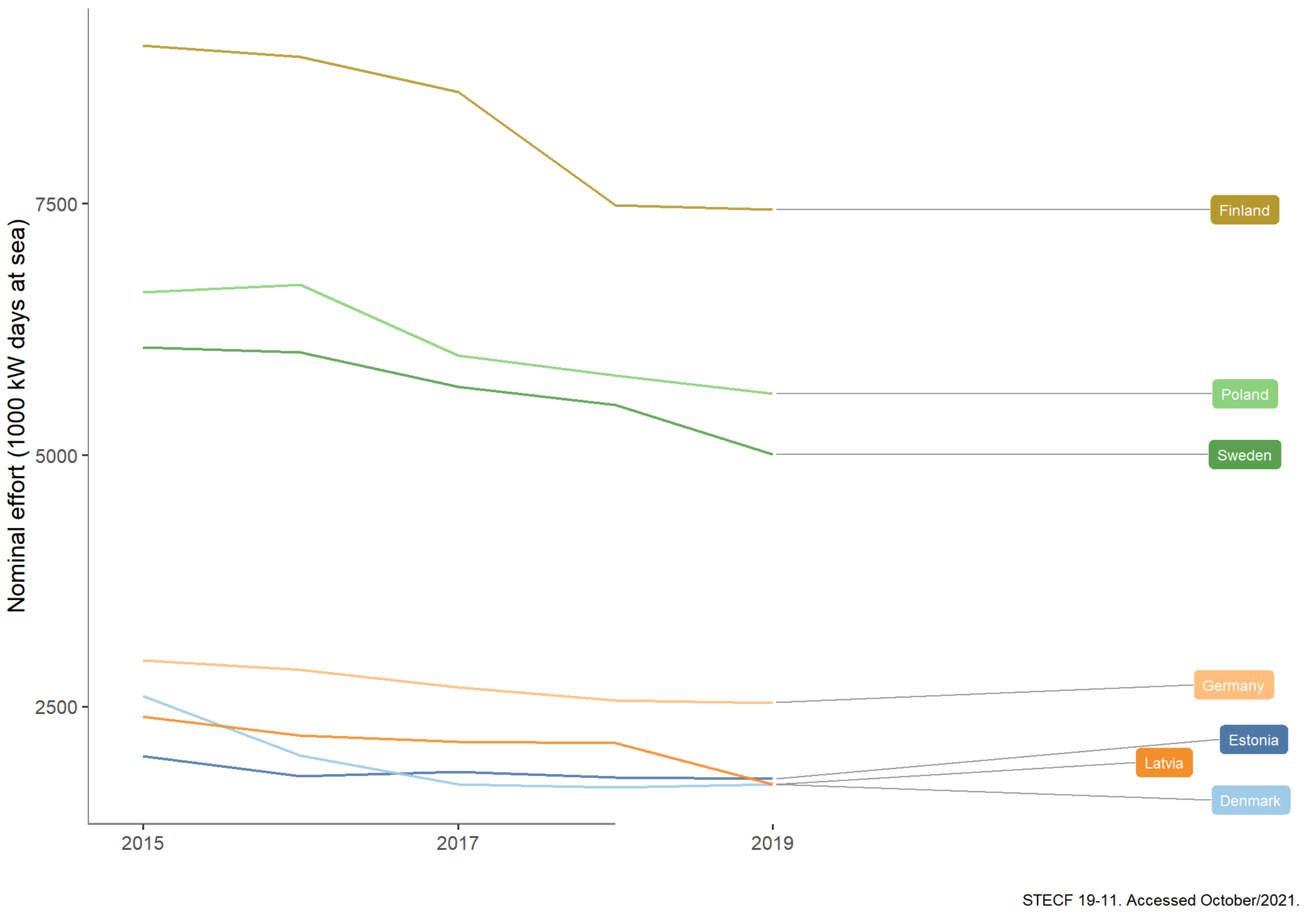


Figure 3 Baltic Sea fishing effort (thousand kW days-at-sea) in 2015–2019, by EU member state. Confidential catches are reported from Belgium, Denmark, Latvia, and Poland.

Catches over time

Species caught in the fisheries are either landed or discarded. Landings and discards are considered separately below. Data on landings have been collected consistently for many years, whereas information on discards has only been consistently collected in the most recent years.

The principal species targeted in the commercial fisheries are cod, herring, and sprat, which together constitute about 95% of the total catch. The fisheries for cod in the Baltic Sea use mainly demersal trawls and gillnets, while herring and sprat are mainly caught by pelagic trawls. Other target fish species having local economic importance are salmon, plaice, flounder, dab, brill, turbot, pikeperch, pike, perch, vendace, whitefish, turbot, eel, and sea trout.

Landings

Since the early 1950s, landings of herring and sprat from the pelagic fisheries have dominated the total landings of fish from the Baltic Sea (Figures 4 and 5) which peaked at more than 1.2 million tonnes in the mid-1970s. A decrease in sprat abundance, followed by a decline in cod in the late 1980s, led to a marked decline in total landings. Pelagic landings increased in the early and mid-1990s, reflecting an increase in sprat abundance during this period. Since 2003, total Baltic Sea landings have remained fairly stable (Figure 6).

Recreational catches are included in ICES assessments of the western Baltic cod and the Baltic salmon and sea trout stocks. Estimated annual recreational catch of western cod has been relatively stable at around 2500 tonnes, while estimated annual recreational catches of salmon have been more variable, and sea trout catches have been increasing in recent years. National recreational fishery surveys have been conducted in the Baltic; however, availability of time series data is incomplete and only few data for other species are available. Therefore, the regular inclusion of recreational data in assessments for the whole Baltic Sea remains an issue.

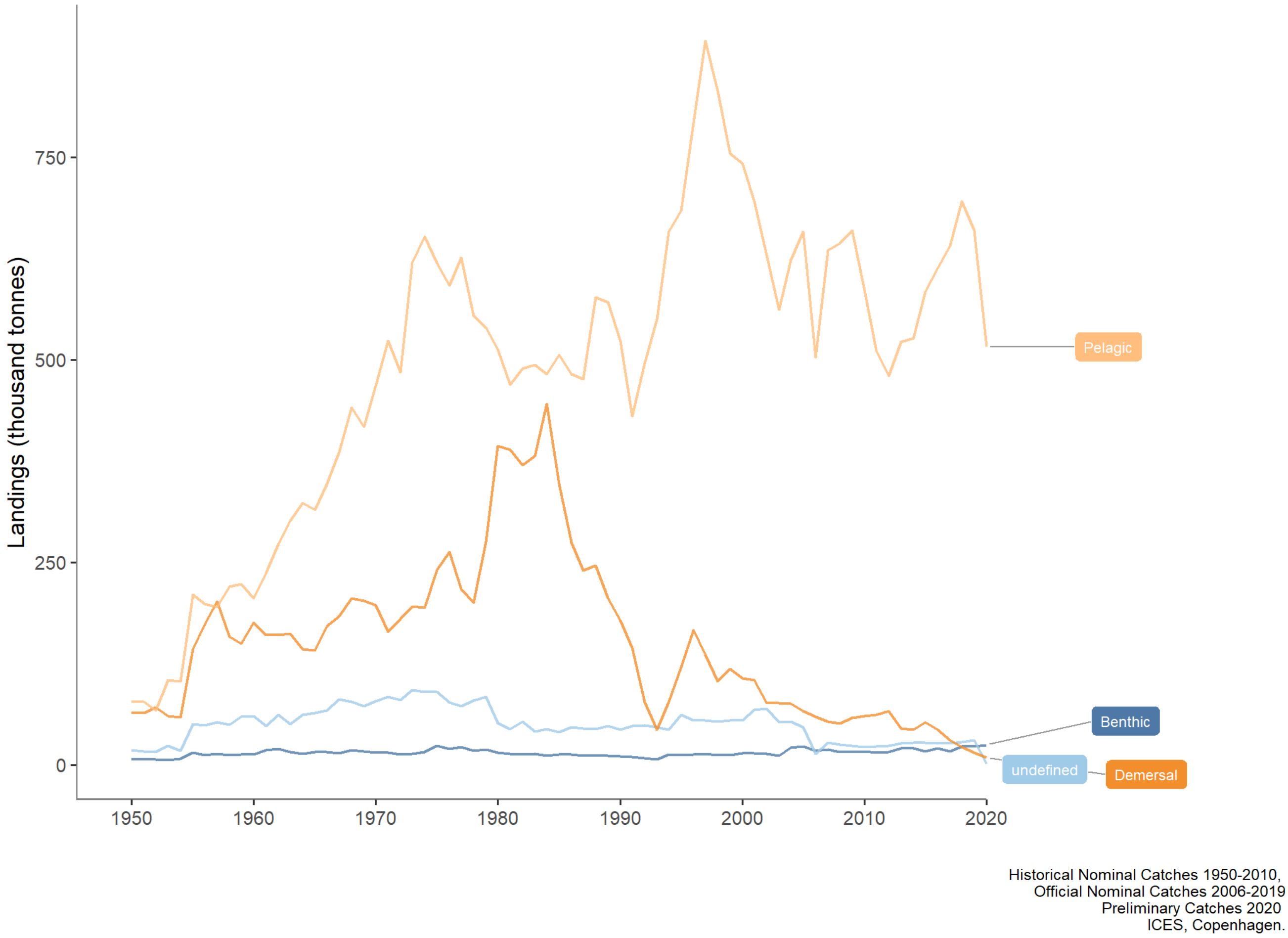


Figure 4 Landings (thousand tonnes) from the Baltic Sea in 1950–2020, by fish category. Table A1 in the Annex details which species belong to each fish category.

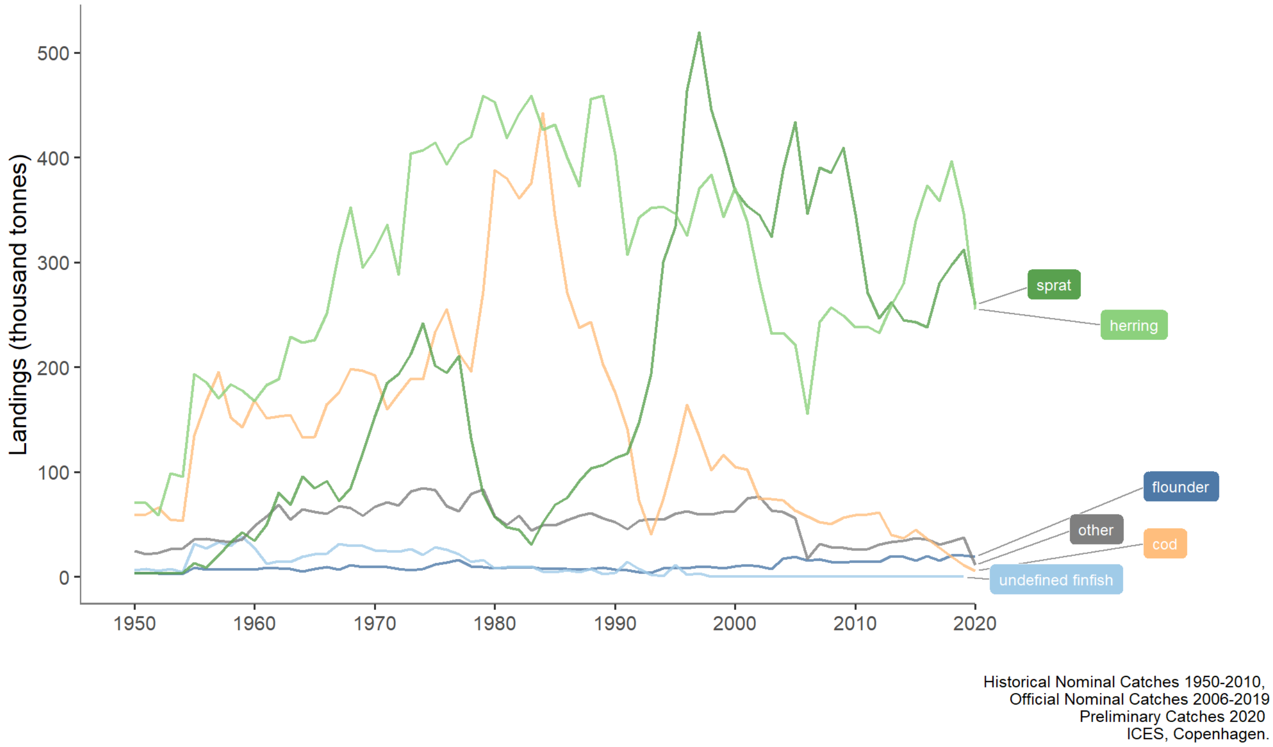


Figure 5 Landings (thousand tonnes) from the Baltic Sea in 1950–2020, by species. The five species with the highest landings are displayed separately; the remaining species are aggregated and labelled as "other". The "undefined finfish" category is due to inadequate reporting in early years.

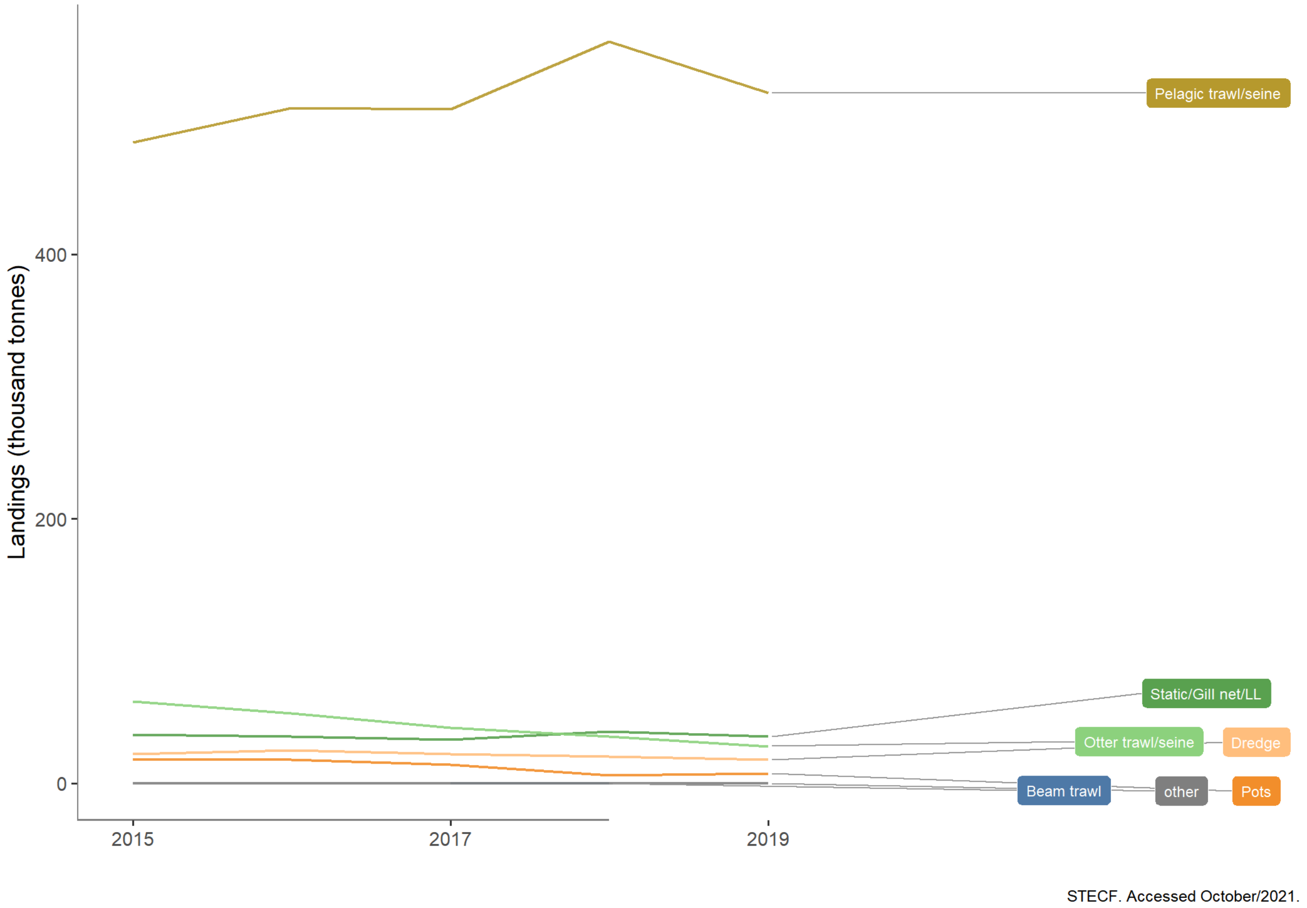


Figure 6 Commercial landings (thousand tonnes) from the Baltic Sea in 2015–2019, by gear type (LL = longline). Confidential catches are reported from Belgium, Denmark, Latvia, and Poland.

Discards

Discards for pelagic species in the Baltic Sea are very low, as both sprat and herring are target species (Figure 7) and other bycatch (e.g. of sticklebacks) is also landed. The discard rates are minor for static coastal gears and even lower for pelagic trawls. The highest discard rate is for the benthic species; however, it has been decreasing since 2016. An overall decreasing trend is also seen for demersal discard rates, Release rates for species targeted by recreational fisheries are available for most target species and are high, but vary between years and countries. Post-release mortality estimates are available only for some species; further studies are needed.

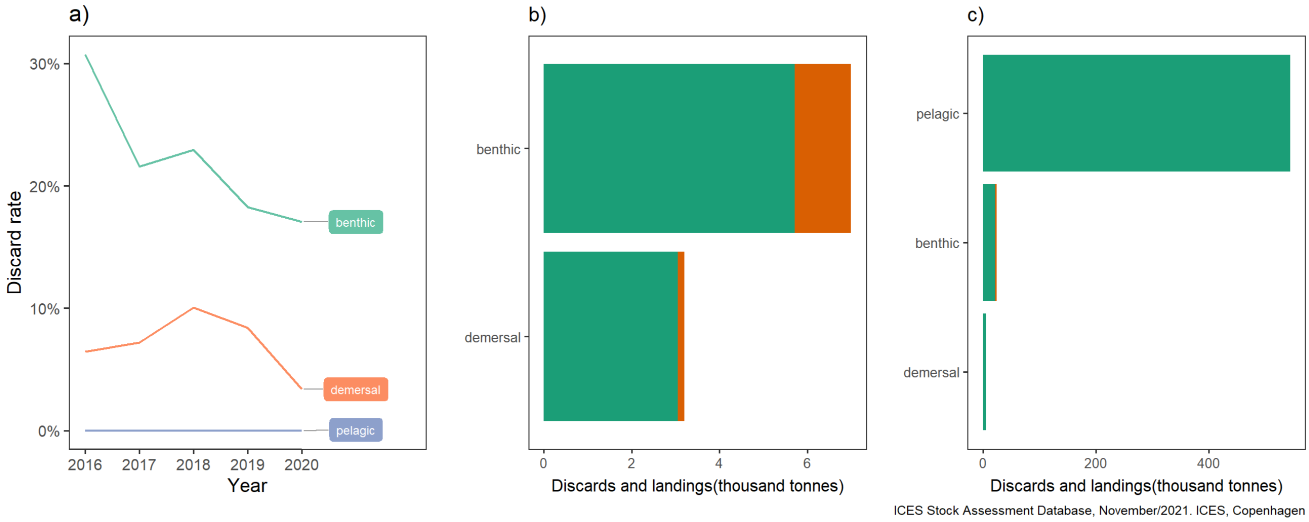


Figure 7 Left panel (a): Discard rates in 2016–2020 by fish category, shown as percentages (%) of the total annual catch in that category. Middle panel (b): Landings (green) and discards (orange) in 2020 by fish category (in thousand tonnes) only of those stocks with recorded discards. Right panel (c): Landings (green) and discards (orange) in 2020 by fish category (in thousand tonnes) of all stocks. (Note that not all stock catches are disaggregated between landings and discards).

Description of the fisheries

The principal species targeted in the commercial fishery are cod, herring, and sprat, which constitute about 95% of the total catch. Other target fish species having local economic importance are salmon, plaice, dab, brill, turbot, flounder, pikeperch, pike, perch, vendace, whitefish, turbot, eel, and sea trout.

Bottom trawls are the main gear used in Baltic demersal fisheries, while mid-water trawls are the main gear in the pelagic fisheries. Demersal fishing effort has substantially declined since 2004 (Figure 8).

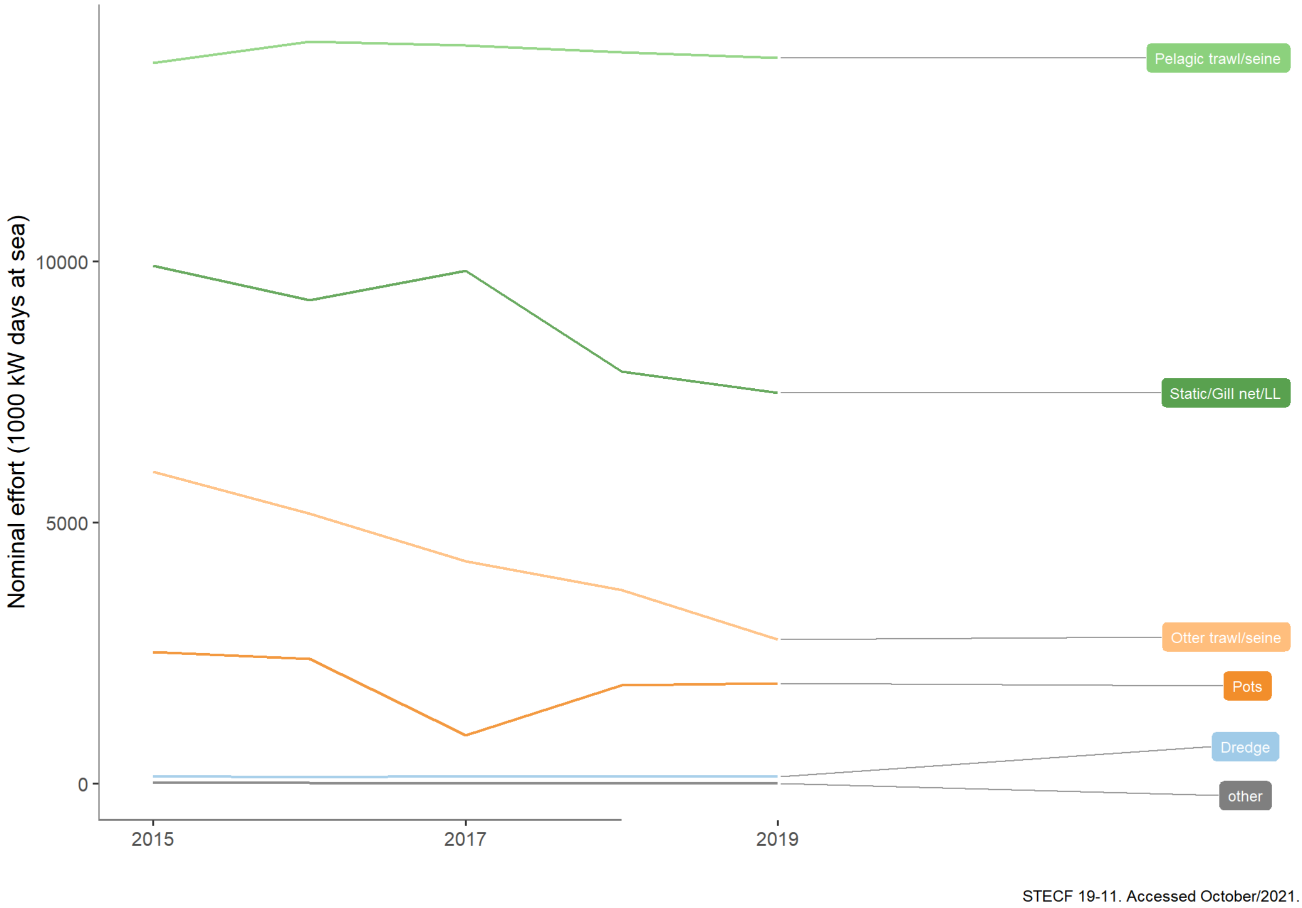


Figure 8 Baltic Sea fishing effort (thousand kW days at sea) in 2015–2019 by EU vessels, by gear type. Confidential catches are reported from Belgium, Denmark, Latvia, and Poland.

The spatial distribution of fishing effort by different gear types is shown in Figure 9. These maps show the distribution of effort by vessels >12 m carrying vessel monitoring systems (VMS). The substantial effort undertaken also by vessels < 12 m is therefore not included.

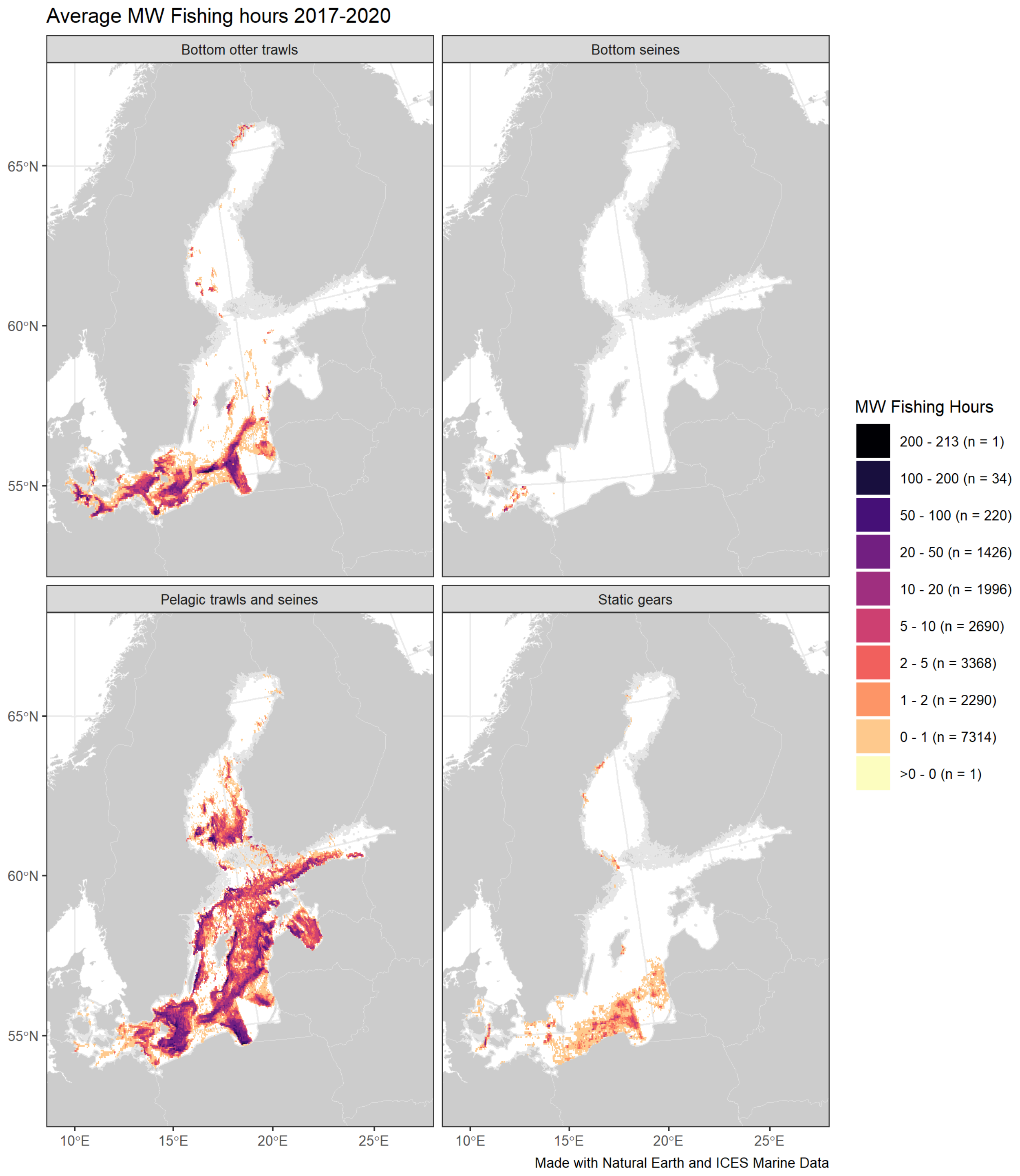


Figure 9 Spatial distribution of average fishing effort (MW fishing hours) in the Baltic Sea by gear type. Fishing effort data are only shown for vessels > 12 m carrying vessel monitoring systems (VMS).

Bottom trawl and seine

The bottom trawl is the most common gear in the southwestern part of the region, being intensively used by all countries. Cod is typically the main target species with flatfish as bycatch; however, in certain time periods and areas, demersal trawlers may target flatfish. To a minor extent, small-meshed bottom trawls are used for catching herring and sprat. The bottom trawls used in the cod and flatfish fisheries are subject to detailed design and mesh size rules. Demersal seines are also used in the southwestern Baltic Sea. Beam trawls are generally not used in the Baltic Sea.

Dredge

Dredge fisheries target blue mussels in Subdivision 22.

Gillnets

Set gillnets are widely used in the Baltic Sea, both in offshore fisheries targeting cod, flatfish, and herring and in coastal fisheries exploiting a large variety of species, including cod, flatfish, herring, whitefish, pikeperch, perch, and pike. Drifting gillnets have been banned in the Baltic Sea since 2008.

Longline

Longline fisheries target cod, salmon, and sea trout in the western and central Baltic Sea, and eel in coastal areas. Following the ban on driftnets, longlines have become the most important gear in the offshore salmon fishery.

Pelagic trawl and seine

Pelagic trawl and seine fisheries operate in all parts of the Baltic Sea, targeting herring and sprat. The catch of each species varies with season and area. Catches are used for human consumption as well as fishmeal and oil production.

Trapnets and fykenets

The trapnet fishery includes a variety of trap types for herring, salmon, whitefish, eel, and other freshwater species. Fisheries are conducted near the coast and inside archipelagos. The trap fishery for herring operates primarily during the spawning season in spring and early summer. Trapnets are used to target salmon on their spawning migration. In the northern and central Baltic Sea, most trapnets and fykenets are equipped with seal exclusion devices.

Recreational fisheries

Recreational fisheries take place in all parts of the Baltic Sea, using a variety of gears including rod and line, longline, gillnets, traps, and spear-fishing. Recreational fisheries catch the same species as the commercial fisheries but also several other species. For most of the stocks, recreational catches are neither evaluated nor included in the stock assessments. However, for the salmon and western Baltic cod stocks, recreational catches are significant and are included in the ICES assessments of the stocks.

Fisheries management

Baltic Sea fisheries management is under the EU's Common Fisheries Policy (CFP) and Russian- Federation legislation. The EU fisheries management includes input from the Regional Baltic Sea Fisheries Forum (BALTFISH) and the Baltic Sea Advisory Council. Coastal fisheries are managed nationally. Fisheries advice is provided by the International Council for the Exploration of the Sea (ICES) and the European Commission's Scientific Technical and Economic Committee for Fisheries (STECF).

Cod, herring, sprat, salmon, and plaice fisheries are managed using TACs. Technical measures such as restrictions on fishing gear types and specifications to reduce catches of undersized fish are in place for some fisheries. Temporal and spatial closures are implemented to protect spawning cod, salmon, flounder, and plaice, and also to preserve benthic habitats.

In 2016, the EU adopted a multiannual fisheries management plan covering the Baltic Sea fisheries for cod, herring, and sprat. The plan specifies targets and harvest control rules (HCRs) for these stocks and includes management measures to ensure that the stocks of plaice, flounder, turbot, and brill caught as a bycatch in the cod, herring, and sprat fisheries are managed in accordance with CFP objectives. An obligation to land all catch in the cod, salmon, herring, and sprat fisheries in the Baltic Sea was implemented in 2015; a further agreement to include plaice catches in the landings obligations was enacted in 2017.

In 2011, STECF considered that enforcement of the TACs in the Baltic was sufficient to control catches and that, given the relatively limited levels of discards, TACs had been effective in limiting fishing mortalities on the Baltic stocks. Recent estimates of discards in the eastern Baltic cod fishery indicate a minimum of 10% even though the landing obligation has been in place since 2015. Fishing mortality on western Baltic cod has been much too high in the last 19 years, despite a management plan being in place since 2007. Also, a number of flatfish stocks are not regulated by TACs in the Baltic Sea. STECF evaluated the effectiveness of spawning closures in the Baltic in 2011 and concluded that the impact of these measures was unclear. As long as TACs are effective in limiting fishing mortality, STECF concluded that spawning closures have little effect on the overall fishing mortality and therefore might not be required to meet biological objectives. Since then, evidence from elsewhere indicates that spawning closures for cod are beneficial for recruitment (not necessarily for the reduction of fishing mortality, but to improve spawning conditions, for example by avoiding disruption of spawning aggregations). In 2016, STECF evaluated revised spawning closures and concluded that the spatial closure appeared to be greatly beneficial to the western Baltic cod stock. The effectiveness of spatial closures in preserving benthic habitats has not been widely investigated.

STECF also evaluated a number of technical measures, including gear limitations (e.g. mesh sizes), minimum landing size, and maximum bycatch percentages. For cod, STECF concluded that most of these measures have a positive impact on exploitation patterns and therefore a positive impact on the yield-per-recruit. However, the increase of mesh size in Bacoma escape windows from 110 mm to 120 mm in the cod fishery was found to have adverse effects, i.e. increased fishing pressure on larger fish and increased unwanted bycatch of juveniles.

Status of the fishery resources

Fishing mortalities and spawning stock sizes have been evaluated against maximum sustainable yield (MSY) and precautionary approach (PA) reference points, and the status of these stocks has also been assessed relative to safe biological limits. One third of the Baltic stocks that are analytically assessed (ICES stock data category 1) are fished at rates at or above F_{MSY} (Figure 10); this is also in accordance with Marine Strategy Framework Directive (MSFD) D3C1 and the Good Environmental Status (GES) boundaries. However, two thirds of the stocks are fished within the D3C2 boundaries that consider the reproductive capacity of the stocks (Figure 11). There are some stocks for which fishing pressure and stock size reference points are not yet available. The MSFD descriptors show that the majority of the landings are from stocks with full reproductive capacity, which is largely driven by landings of sprat and herring in the Gulf of Bothnia (Figure 11). Overall fishing mortality (F) for benthic and pelagic fish stocks has reduced since the early 2000s (Figure 12). A number of stocks are currently being exploited above F_{MSY}, namely western cod, central Baltic herring, and sprat in the Baltic Sea. Table A1 in the Annex contains a full list of the stocks included in these figures.

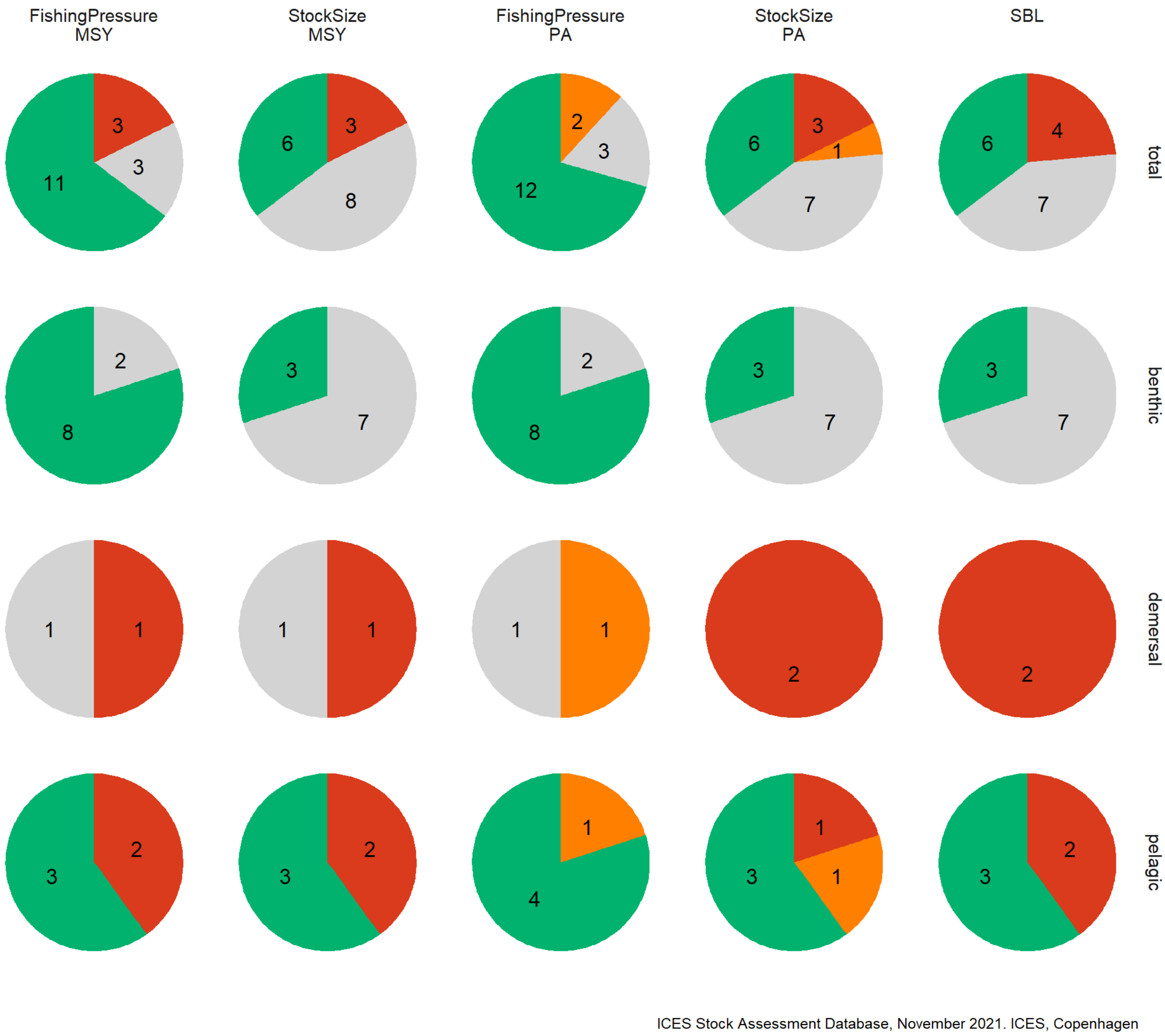


Figure 10 Status summary of Baltic Sea stocks in 2021 relative to the ICES maximum sustainable yield (MSY) approach and precautionary approach (PA) (excluding European eel, salmon, and sea trout). Grey represents unknown reference points. *For the MSY approach*: green represents a stock that is either fished below F_{MSY} or whose stock size is greater than MSY $B_{trigger}$; red represents a stock that is either fished above F_{MSY} or whose stock size is lower than MSY $B_{trigger}$. *For the PA*: green represents a stock that is fished at or below F_{pa} while the stock size is equal to or greater than B_{pa}; orange represents a stock that is either fished between F_{pa} and F_{lim} or where the stock size is between B_{lim} and B_{pa}; red represents a stock that is either fished above F_{lim} or where the stock size is less than B_{lim}. Stocks having a fishing mortality below or at F_{pa} and a stock size above B_{pa} are defined as being inside safe biological limits. If this condition is not fulfilled the stock is defined as being outside safe biological limits. For stock-specific information, see Table A1 in Annex.

Figure 11 Status summary of Baltic Sea stocks in 2021 relative to the Marine Strategy Framework Directive (MSFD) assessment criteria of the level of pressure of fishing activity (D3C1) and reproductive capacity of the stock (D3C2). Green represents the proportion of stocks either fished below F_{MSY} or whose stock size is greater than MSY $B_{trigger}$, for criteria D3C1 and D3C2. Red represents the proportion of stocks either fished above F_{MSY} or whose stock size is lower than MSY $B_{trigger}$, for criteria D3C1 and D3C2. Grey represents the proportion of stocks without MSY reference points. For stock-specific information, see Table A1 in the Annex.

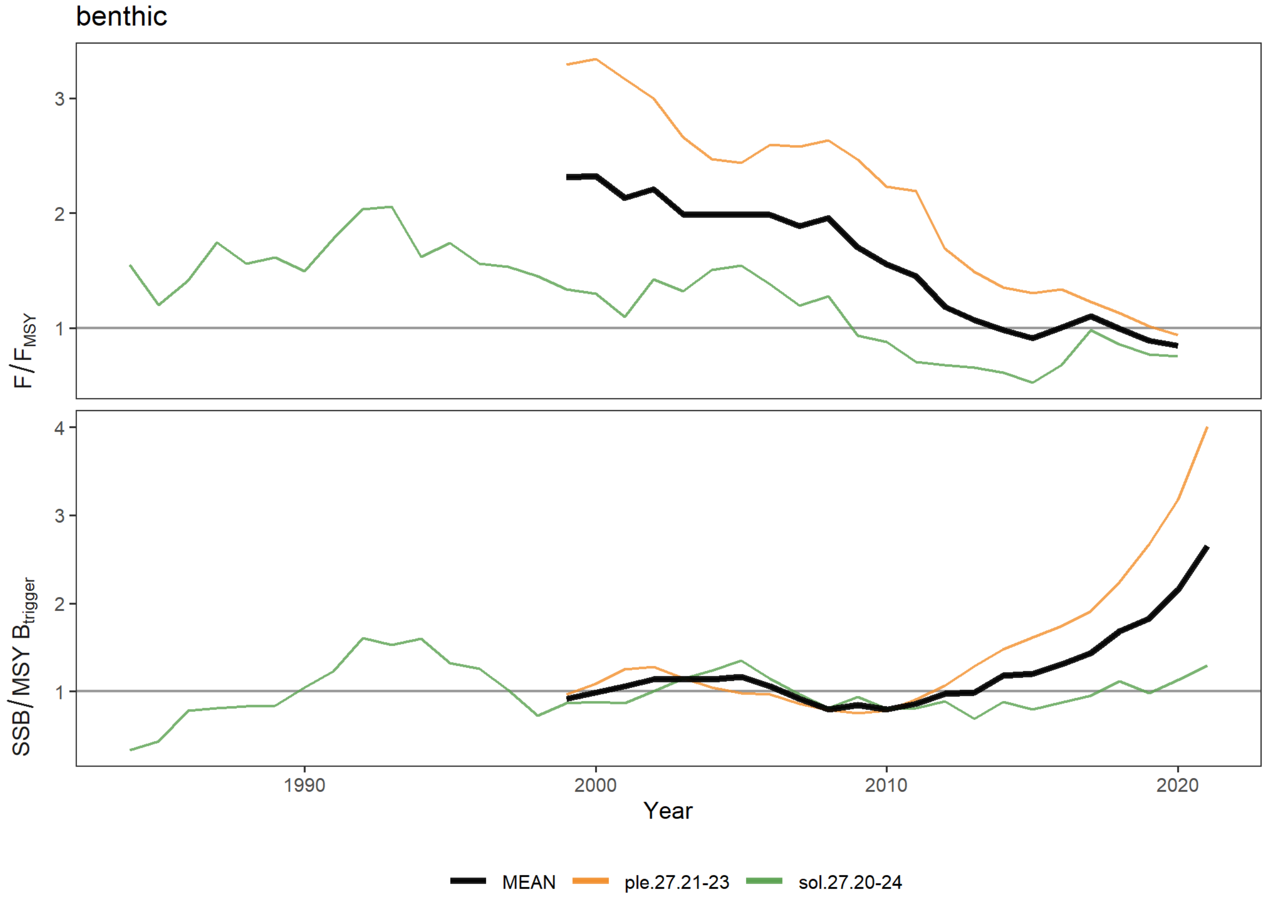


Figure 12a Temporal trends in F/F_{MSY} and SSB/MSY $B_{trigger}$ for Baltic Sea benthic stocks. Only stocks with defined MSY reference points are considered. For full stock names, see Table A1 in the Annex.

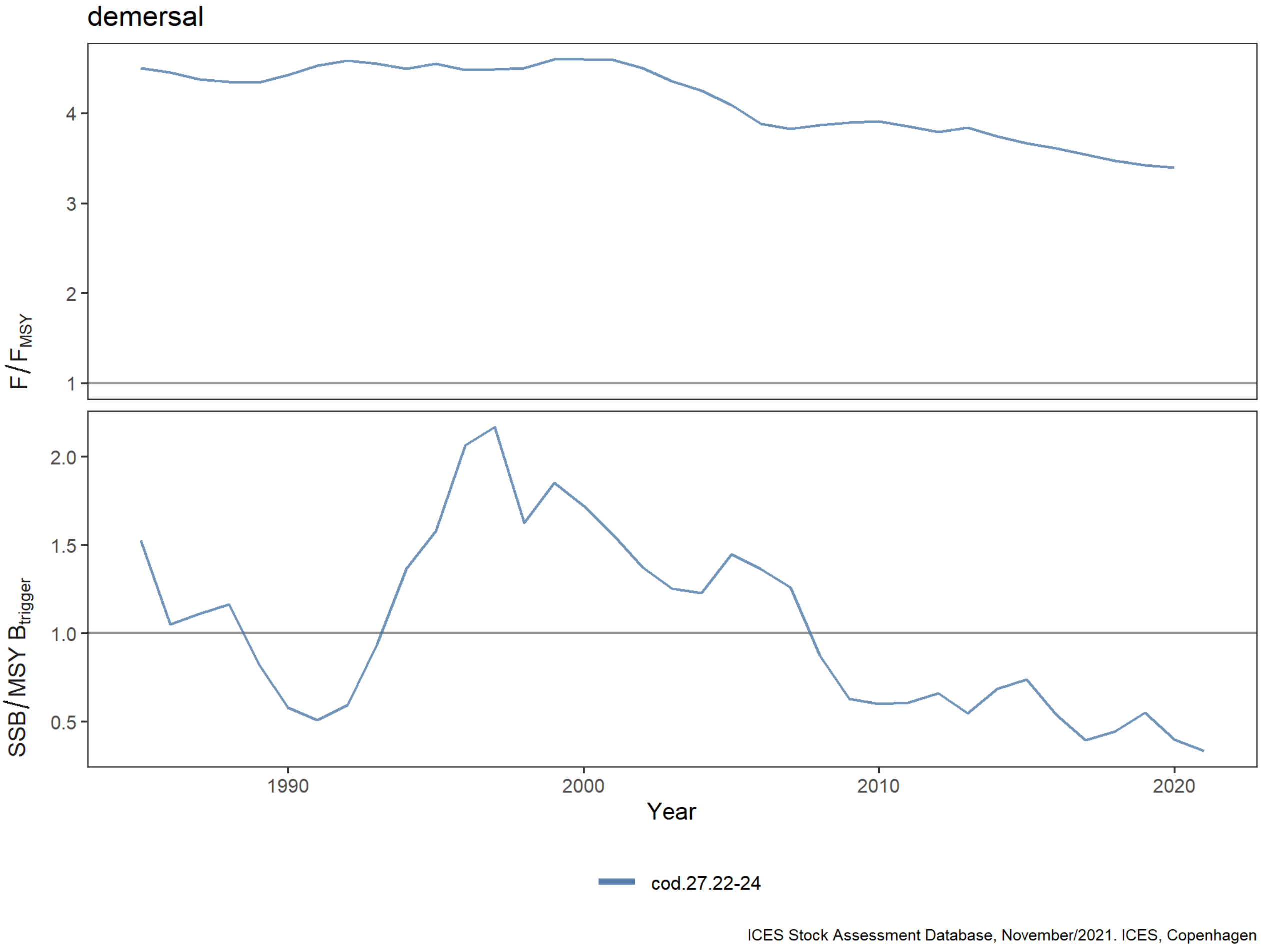


Figure 12b Temporal trends in F/F_{MSY} and SSB/MSY $B_{trigger}$ for Baltic Sea demersal stocks. Only stocks with defined MSY reference points are considered. For full stock names, see Table A1 in the Annex.

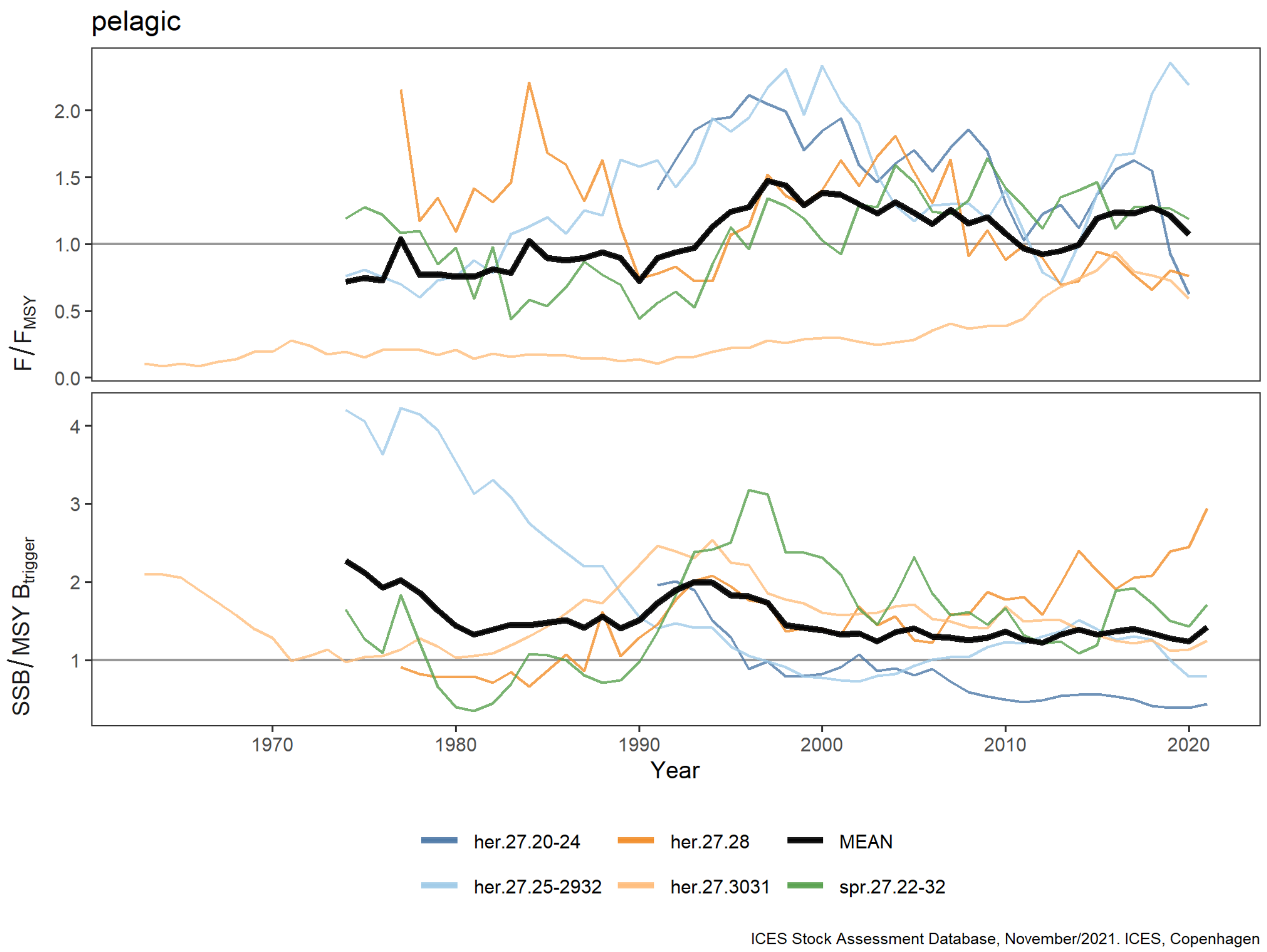
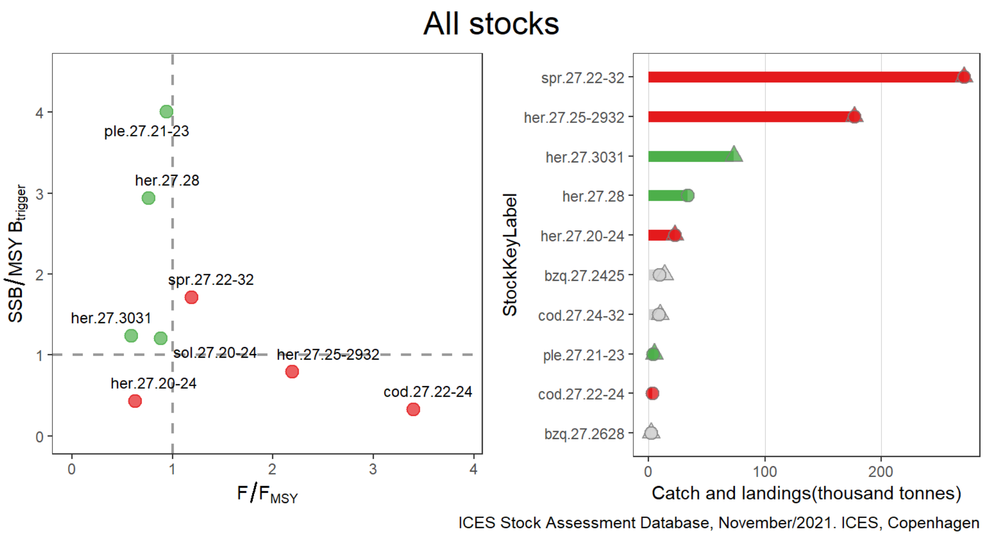
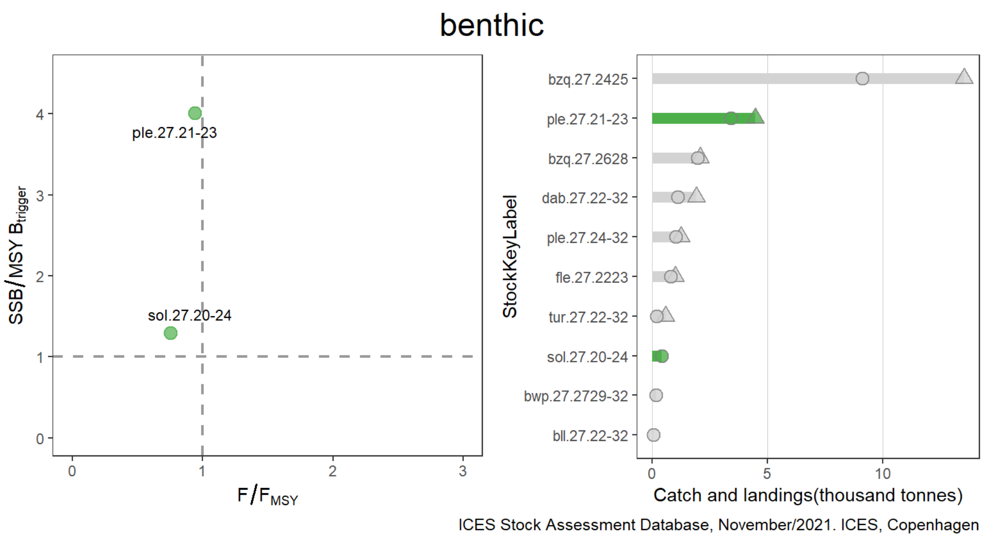


Figure 12c Temporal trends in F/F_{MSY} and SSB/MSY $B_{trigger}$ for Baltic Sea pelagic stocks. Only stocks with defined MSY reference points are considered. For full stock names, see Table A1 in the Annex.





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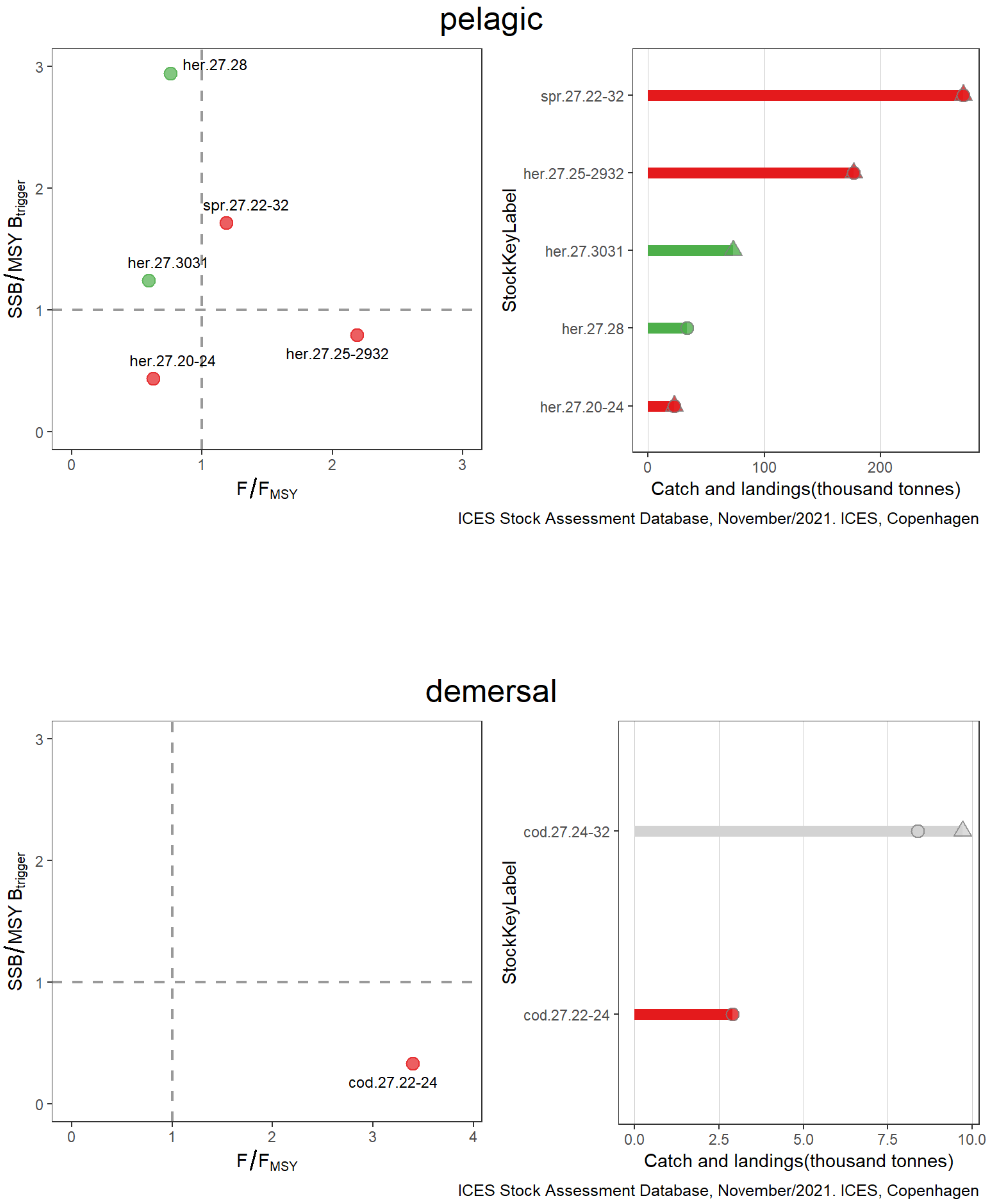


Figure 13 Status of Baltic Sea stocks relative to the joint distribution of exploitation (F/F_{MSY}) and stock size ($SSB/MSY\ B_{trigger}$) [left panels, by individual stocks] and catches (triangles) / landings (circles) from these stocks in 2021 [right panels]. The left panels only include stocks for which MSY reference points have been defined (MSY where available). Stocks in green are exploited at or below F_{MSY} while the stock size is also at or above MSY $B_{trigger}$. Stocks in red are either exploited above F_{MSY} or the stock size is below MSY $B_{trigger}$ or both. Stocks in grey have unknown/undefined status in relation to reference points. “All stocks” refers to the ten stocks with highest catch and landings across fisheries guilds in 2020. For full stock names, see Table A1 in the Annex.

Mixed fisheries

Many fishing gears catch more than one species at the same time, which means “technical interactions” occur between stocks when multiple species are captured in the same gear. Because these interactions may vary through time and space (e.g. interactions might vary between day and night, or between different times of the year, or between different areas), they would ideally be quantified at the scale of the fishing operation. However, most fisheries data, including those submitted to STECF, are aggregated based on species, gear, mesh size range, ICES square, and calendar quarter, which may create perceived interactions that do not occur in real life while more subtle interactions are missed.

ICES has evaluated technical interactions between species captured together in demersal fisheries by examining their co-occurrence in the landings at the scale of the gear, mesh size range, ICES statistical rectangle, and quarter (hereafter called strata). The percentage of landings of species A, where species B is also landed and constitutes more than 5% of the total landings in that stratum, has been computed for each pair of species. Cases in which species B accounts for less than 5% of the total landings in a stratum were ignored.

To illustrate the extent of the technical interactions between pairs of species, a qualitative scale was applied to each interaction (Figure 14). In this figure, the rows represent the share of each species A that was caught in fisheries where species B accounted for at least 5% of the total landings. For example, a high proportion herring catches were taken in fisheries where herring landings constituted at least 5% of the total landings, while the there was a medium quantity of herring in fisheries where sprat accounts for at least 5% of the total landings. The quantities of sprat were high in both the fisheries where herring or sprat accounted for at least 5% of the total catch.

The columns in Figure 14 illustrate the degree of mixing and can be used to identify the main fisheries. Fisheries, where herring (species B) constitute 5% or more of the total landings, account for a high share (red cells) of the total landings of herring and sprat, while the quantity of herring in the fisheries where sprat constitute at least 5% of the total catch was medium (orange cells).

In the Baltic Sea, cod fisheries often capture flounder (and occasionally take plaice and whiting). Occasional fisheries for flounder frequently harvest cod. The Baltic herring fisheries often land also sprat and vice versa.

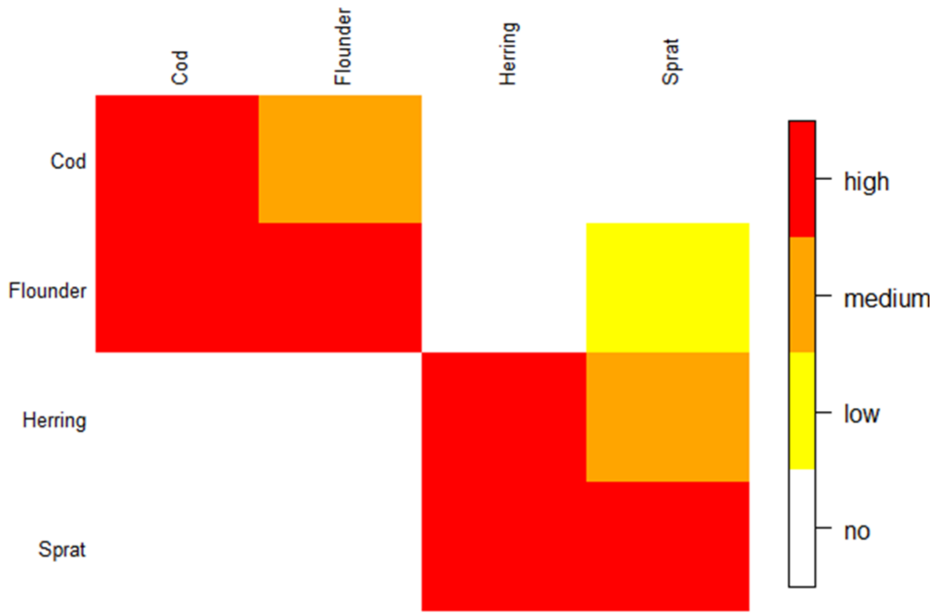


Figure 14 Technical interactions between the four most important stocks in the Baltic Sea. The rows illustrate the fisheries where the species A was caught. The red cells indicate the species B which the A species are frequently caught together with; the orange cells indicate medium interactions; the yellow cells indicate weak interactions. The columns show the degree of mixing in fisheries where species B accounts for at least 5% of the total landings. A more detailed explanation of Figure 14 is provided in the text.

The technical interaction in the Baltic pelagic fishery differs between fisheries. The majority of herring and sprat are caught with pelagic trawls. The pelagic trawlers performing a directed fishery for either sprat or herring have a highly variable degree of mixing in the catches of both species. The degree of mixing varies on a spatial scale (Figure 15). According to logbooks and sales slips, this mixing can vary between < 5% and 40%, although these percentages are not quantifiable at this stage. Given that the information available on the mixing in the directed single-species pelagic fishery is based on logbooks and sales slips and thus on a trip basis, the actual mixing in the individual hauls is at present unknown. The directed herring fishery close to Bornholm in subdivisions 23–25 is reported to have less sprat in the catches than further north in the Baltic (subdivisions 27–29). Mixing of herring and sprat in the directed herring trawl fishery is highest in Subdivision 32, decreasing further north in subdivisions 30–31. The vast majority of the total herring landings in subdivisions 30–31 are not for human consumption and these landings tend to be mixed. The majority of the landings in the directed herring trawl fishery are for human consumption, but there are also landings for industrial purposes. Herring is caught as a bycatch in the directed sprat fishery, which mainly takes place in the central part of the Baltic and Gulf of Finland. Landings in this fishery are mainly for industrial purposes, but there are also landings for human consumption. The directed sprat fishery shows the same spatial variation in a mixture of herring and sprat as the directed herring fishery. However, a low spatial overlap of the directed herring and sprat fishery has been reported.

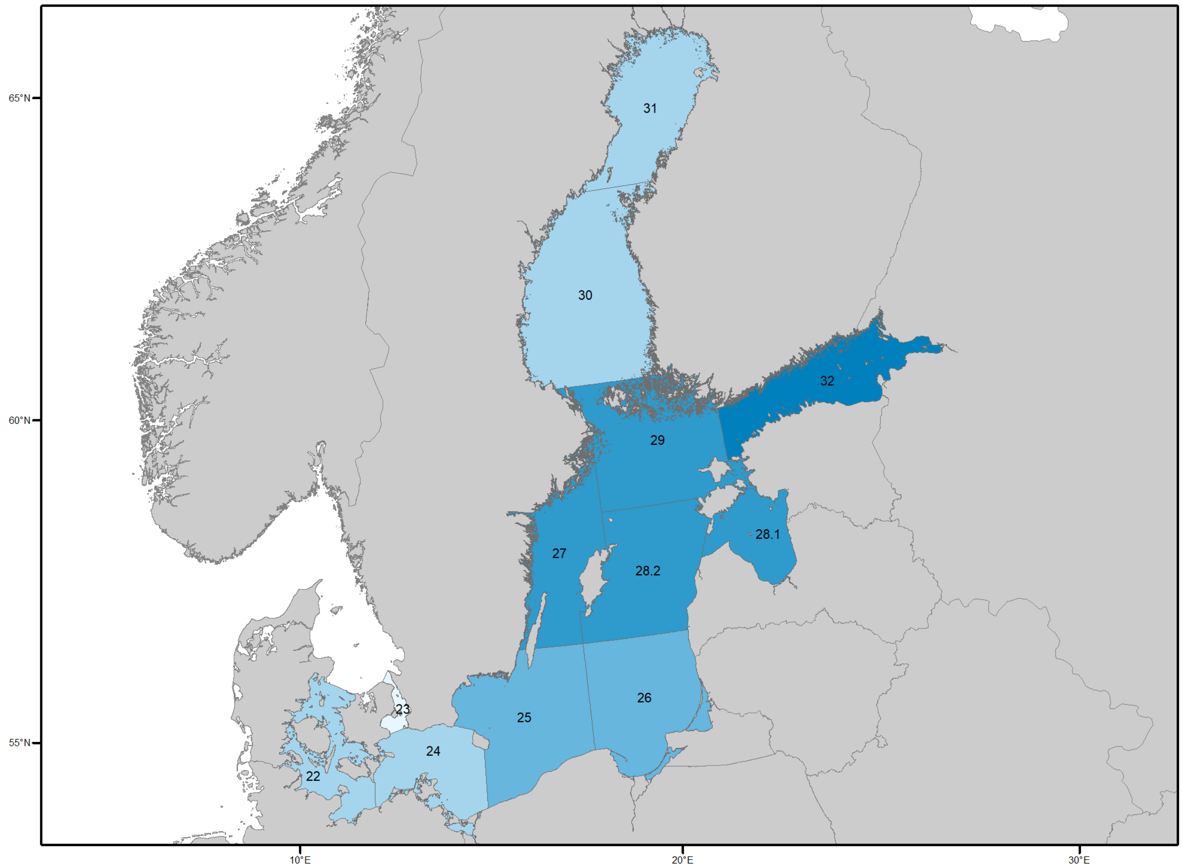


Figure 15 Spatial variation in reported mixing of herring and sprat in trawl fishery in the Baltic. A darker colour indicates higher mixing.

The species composition in trawl hauls in these directed fisheries is also reported to vary on a seasonal scale. Reporting from sales slips and logbooks show that there are higher concentrations of sprat in the directed herring trawl fishery in the first and fourth year-quarters, particularly in the northern parts of the Baltic Sea (Subdivisions 27-32, excluding the Bothnian Sea); the first and fourth quarters are also the main fishing seasons.

The coastal fisheries with smaller vessels targeting herring with gillnets and trapnets have a low degree of actual mixing in the catches and are predominantly clean herring fisheries with less than 5% mixing of sprat in the catches. If sprat is caught as bycatch, mixing is less than 5%.

In addition to the directed single-species pelagic fishery, there is a small-meshed fishery for industrial purposes which has quite a high degree of mixing of herring and sprat.

Cod and flounder account for the highest landings of demersal species in the Baltic. The majority of the landings are made with demersal trawls, but there are also significant landings with gillnets. The otter trawlers and gillnetters also land other demersal species: dab, plaice, and whiting.

No mixed-fisheries advice has been developed yet for the Baltic Sea.

Species interaction

The major considerations for the Baltic Sea cover the eastern cod stock, the central herring stock, and the sprat stock. Eastern Baltic cod is a predator on herring, sprat, and juvenile cod (Figure 16). This predation by cod forms the main interactions among these stocks.

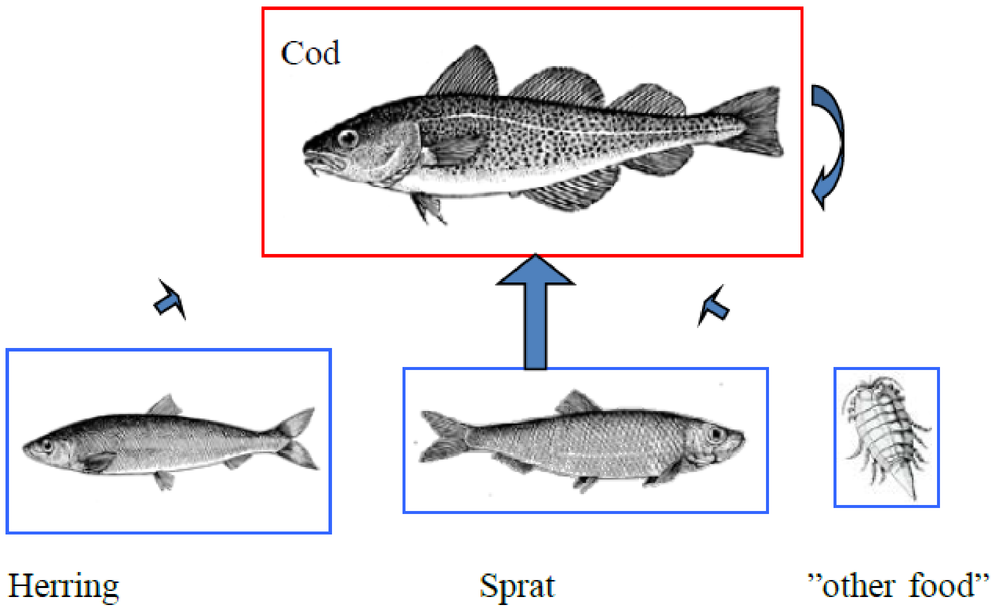


Figure 16 The main Baltic Sea food web.

In the Baltic Proper (Subdivisions 24-29, excluding 28.1), multispecies analyses indicate that trade-offs exist between fishing on cod or herring and sprat. Increased fishing pressure on cod may increase the risk of a low cod stock size, thereby reducing cod predation on sprat and herring and allowing higher survival in these two prey species. Increased fishing pressure on herring and sprat may have a negative impact on the condition and growth of cod (by reducing the forage available for cod) and result in lower cod yields. The magnitude of the interaction between the species depends on the spatial and temporal overlap among the three stocks. Currently, the eastern Baltic cod stock is at such a low level that its impact on herring and sprat mortality rates can be considered to be very low.

In the last two decades, the two Baltic cod stocks have decreased, while the flounder and plaice stocks in the Baltic have increased. The increase in flounder may be at least partially ascribed to the release from cod predation. As flounder is currently not included in the multispecies models for the Baltic Sea, no estimates of predation mortality rates or interspecific competition for food are available.

Three seal species occur regularly in the Baltic Sea: grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*), and ringed seal (*Phoca hispida*). While grey seals are present throughout the Baltic Sea and are in good status in most parts of the distribution area, the latter is not the case for the other two seal species. The grey seal population grew rapidly between 2000 and 2016, before levelling off at above 30 000 individuals. Herring, sprat, cod, flounder, and salmonids may have high occurrence in the diet of seals and consumption by seals has been estimated to be significant in some areas of the Baltic Sea. In the Bothnian Bay, the annual ringed seal consumption on herring was estimated in 2008 to be higher than the catches from the Swedish and Finnish fishery. Also, seal consumption in 2004 was estimated to be comparable with catches of salmonids in the Baltic Sea. Considering the increasing population of grey seals in the last decade, the effects of seals on fish stocks are likely to have also increased, although no estimations have been recently available.

Studies have also shown that bird (mainly cormorants) predation can locally affect fish populations, including flatfish, but their effects on the fish stocks are not yet quantified.

Fishes host several parasites, with potential negative effects on their health. In the Baltic Sea, the grey seal population has increased markedly since the early 2000s. The grey seal is the main definitive host to the liver worm *Contracaecum osculatum*, a parasitic nematode to which cod is one of several intermediate hosts. Recent investigations have shown a marked increase in prevalence and abundance of infection of this parasite in livers of cod inhabiting the central Baltic Sea. Prevalence and abundance of *C. osculatum* in cod livers differ significantly between the eastern and western Baltic Sea, with the highest levels of infection occurring in the low-salinity central (eastern) Baltic areas (East-Gotland Basin). Highly infected fish in the east have significantly lower condition factors than their westerly, less infected conspecifics. Spatial differences in local seal abundance and seal species, salinity, and feeding ecology may explain the observed differences in *C. osculatum* infection between eastern and western Baltic cod. It is not yet clear whether a high infection rate is a cause or the effect of low cod condition.

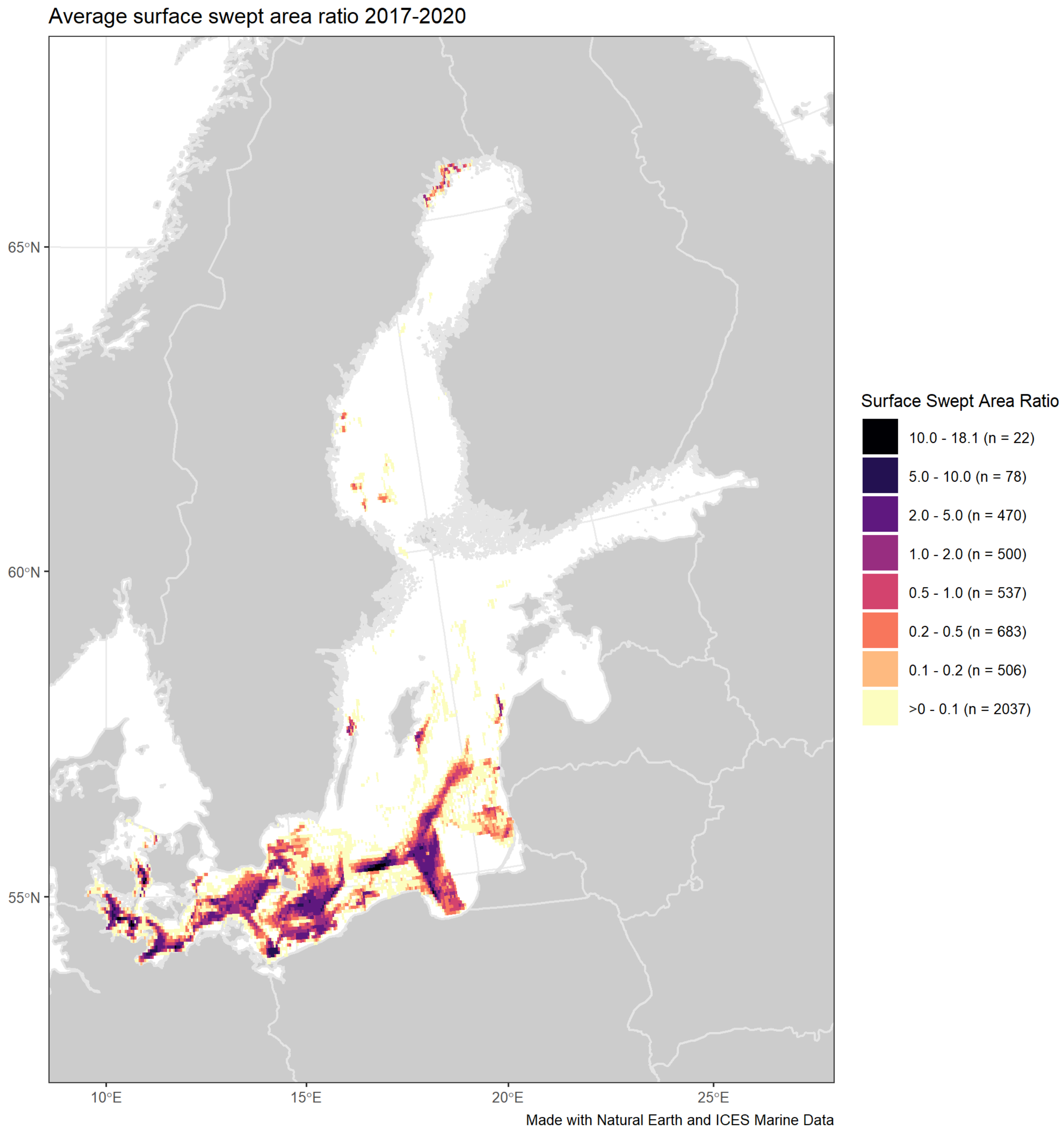
Immature cod feed almost exclusively on benthic prey. In the last decade, juvenile eastern Baltic cod have been feeding at a lower rate than previously, resulting in severe growth limitation and increased starvation-related mortality. At the population level, this results in a reduction in size-at-age and low population abundance. The low feeding levels most probably result from a decrease in benthic prey availability due to increased hypoxic areas. This food reduction is amplified by the accumulation of cod of smaller size competing for the scarce benthic resources. Only the fishes with feeding levels well above average will survive, though growing slowly. These results suggest that there is a relationship between consumption rate, somatic growth, and population density. The consequences for species interactions and ecosystem functioning are strongly environmentally mediated and hence not stable under environmental change.

The invasive round goby (*Neogobius melanostomus*) has become established in all Baltic Sea sub-basins and is continuously increasing its range and abundance in the recently colonized habitats. The species has become the predominant fish species in many coastal areas and poses strong predatory pressure, essentially on epibenthic mollusks. It is suggested that the high densities of round goby at the Lithuanian coast have locally depleted previously dense blue mussel (*Mytilus edulis*) banks. In regions where round gobies have become abundant, they have become important prey items to both avian and fish predators: round goby is the main food item for cod and perch (*Perca fluviatilis*) in the Gulf of Gdansk, an increasingly important prey for perch in Estonia, and also an important prey item for great cormorant (*Phalacrocorax carbo*) and grey heron (*Ardea cinerea*), contributing locally up to 60–95% to their diets. In Lithuania, round gobies were found in the diet of most piscivorous fish species, including turbot (*Scophthalmus maximus*) and even such species as shorthorn sculpin (*Myoxocephalus scorpius*). Certain piscivorous and commercially valued fish can potentially benefit from round goby.

There are other important species interactions. The thiamine deficiency syndrome M74 is a reproductive disorder, which causes mortality among yolk-sac fry of Baltic salmon. The development of M74 is caused by a deficiency of thiamine in the salmon eggs that, in turn, is suggested to be coupled to an abundant, but unbalanced fish diet with too low a concentration of thiamine in relation to fat and energy content. The intake of thiamine for Baltic salmon in relation to energy and fat remains lowest by eating young clupeids, especially young sprat. Although a large sprat stock may have a positive impact on salmon growth, it may increase M74 and thereby mortality of Baltic salmon fry.

Effects of fisheries on the ecosystem

Abrasion of the seabed by mobile bottom-contacting fishing gears has been investigated to describe the extent, magnitude, and effects of fishing on benthic habitats. Mobile bottom-contacting gears are primarily used in the southern areas of the Baltic Sea (Figure 17). This is mainly abrasion from otter trawls targeting demersal and benthic fish. Abrasion may affect the surface (top 2 cm of sediments) or the subsurface (> 2 cm).



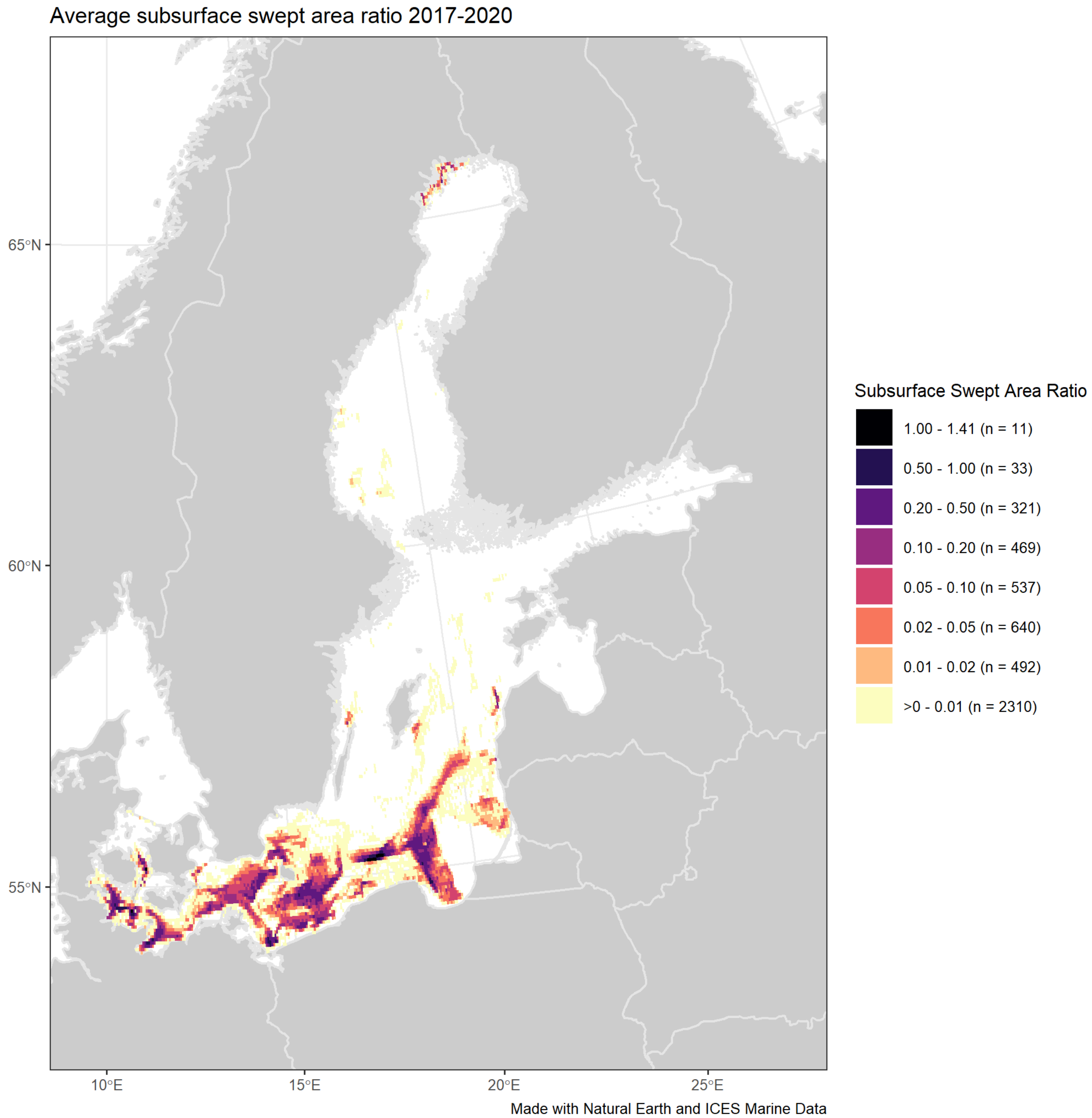


Figure 17 Average annual surface (upper) and subsurface (lower) abrasion by mobile bottom-contacting fishing gear (otter trawls, dredges, and demersal seines) deployed in the Baltic Sea, expressed as average swept-area ratios (SAR). The apparent abrasion on the seabed of the Bothnian Sea is caused by erroneous gear coding; no bottom-contacting mobile gears are used in this area.

Fishing gear disturbances of bottom substrates inflict damage on benthic communities, but little was known until very recently at the regional scale about the sensitivity of different Baltic Sea organisms and communities to the fishery-induced impacts. A mechanistic, quantitative assessment procedure based on biological principles evidenced that communities in low-salinity areas are more resilient to fishing than those in saline areas (van Denderen *et al*. 2020).

All fisheries have the potential to catch protected, endangered, or threatened species, such as seabirds and marine mammals, as non-targeted bycatch. Recording of the catch of seabirds and mammals has been undertaken in some Baltic Sea fisheries, usually where there is perceived risk of such bycatch. Seabirds can become entangled in gillnets or hooked on longlines and consequently drown. Seals can be caught in submersed trapnets and harbour porpoises become entangled in gillnets, leading to the deaths of these animals.

Studies conducted between 1980 and 2005 indicated that at least 76 000 birds, mostly sea ducks, were killed annually in Baltic Sea gillnets. This number may have declined in more recent years, probably due to the decline in sea duck populations, but also decline in fishing effort. Birds that actively pursue their prey underwater were more susceptible than those that graze on the benthos. For three bird species (greater scaup [*Aythya marila*], common guillemot [*Uria aalge*], and long-tailed duck [*Clangula hyemalis*]), gillnet bycatch could pose a threat. Relatively high bycatch rates in nets in 2018 involved the Great cormorant *Phalacrocorax carbo* in the third quarter in the East of Gotland and Gulf of Riga (0.71 specimens per monitored days-at-sea).

The only cetacean species to occur regularly in the Baltic Sea is the harbour porpoise (*Phocoena phocoena*), whose abundance has declined in the Baltic Proper in the past 50–100 years. With the most recent estimation at around 500 individuals (95% confidence interval: 80–1091), this subpopulation is listed as critically endangered. The more westerly Belt Sea subpopulation in Subdivision 22 has a much higher abundance, estimated at around 40 000 individuals. Dead harbour porpoises exhibiting evidence of gillnet entanglements are found and reported regularly. Bycatch in gillnets is adversely affecting this species, particularly the critically endangered Baltic Sea subpopulation.

Abandoned, lost, or otherwise discarded fishing gear (ALDFG) are an unsolved and "silent" problem. Such gear may continuously catch fish, birds, and marine mammals for a long time. It was estimated that 0.1% of nets are lost annually in the Swedish Baltic Sea gillnet fishery. The impact on the environment is not quantified. However, there is information that fishing pressure exerted by lost static nets could range from 20% of its usual net capacity after three months, down to a maximum of 6% after two years.

Fisheries have a large impact on the upper trophic levels of the Baltic ecosystems. In the eastern Baltic, this impact has been shown to cascade down the food web, affecting indirectly the lower trophic levels. For example, the reduction of the eastern Baltic cod stock in the late 1980s has favoured the increased biomass of its main fish prey, the zooplanktivorous sprat, and in turn the decrease in the summer biomass of zooplankton in the Baltic proper. This has provoked a decline in the body condition and growth of both sprat and herring. There is further indication that this trophic cascade could also have facilitated the observed increase in phytoplankton biomass and therefore worsened the eutrophication symptoms.

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Annex

Supporting data used in the Baltic Sea Fisheries overview is archived at ICES (2021).

The following annex table is a status summary of the Baltic Sea stocks in 2021.

Table A1 Status summary of Baltic Sea stocks in 2021 relative to maximum sustainable yield (MSY) and the ICES precautionary approach (PA) (excluding salmon and sea trout). Grey represents unknown reference points. For MSY: green represents a stock that is fished below F_{MSY} or the stock size is greater than MSY $B_{trigger}$; red represents a stock that is fished above F_{MSY} or the stock size is lower than MSY $B_{trigger}$. For PA: green represents a stock that is fished below F_{pa} or the stock size is greater than B_{pa}; yellow represents a stock that is fished between F_{pa} and F_{lim} or the stock size is between B_{lim} and B_{pa}; red represents a stock that is fished above F_{lim} or the stock size is less than B_{lim}. Stocks having a fishing mortality below or at F_{pa} and a stock size above B_{pa} are defined as being inside safe biological limits. Grey represents stocks for which reference points are unknown. Stock codes contain a hyperlink for the most recent ICES advice.

Stock name	Stock description	Fisheries guild	Data category	Assessmen year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
bwp.27.2729-32	Baltic flounder in subdivisions 27 and 29–32	Benthic	3.2	2021	PA/Stock status only	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
bzq.27.2425	Flounder in subdivisions 24 and 25	Benthic	3.2	2021	PA/Stock status only	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
bzq.27.2628	Flounder in subdivisions 26 and 28	Benthic	3.2	2021	PA/Stock status only	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
cod.27.22-24	Cod in subdivisions 22-24, western Baltic stock	Demersal	1	2021	MP	✗	✗	Maximum sustainable yield	✗	✗	✗	✗
								Precautionary approach	o	✗	o	✗
cod.27.24-32	Cod in subdivisions 24-32, eastern Baltic stock	Demersal	1	2021	PA	✗	?	Maximum sustainable yield	?	?	?	?
								Precautionary approach	?	✗	?	✗
dab.27.22-32	Dab in subdivisions 22-32	Benthic	3.2	2020	PA/Stock status only	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
fle.27.2223	Flounder in subdivisions 22 and 23	Benthic	3.2	2019	PA/Stock status only	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?

Stock name	Stock description	Fisheries guild	Data category	Assessmen year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
her.27.20-24	Herring in subdivisions 20-24, spring spawners	Pelagic	1.2	2021	MSY	✗	✗	Maximum sustainable yield	✓	✗	✓	✗
								Precautionary approach	✓	✗	✓	✗
her.27.25-2932	Herring in subdivisions 25-29 and 32, excluding the Gulf of Riga	Pelagic	1	2021	MP	✗	✗	Maximum sustainable yield	✗	✗	✗	✗
								Precautionary approach	O	O	O	O
her.27.28	Herring in Subdivision 28.1	Pelagic	1	2021	MP	✓	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
her.27.3031	Herring in Subdivisions 30 and 31	Pelagic	1	2021	FMSY Ranges	✓	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
ple.27.21-23	Plaice in subdivisions 21-23	Benthic	1	2021	MSY	✓	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
ple.27.24-32	Plaice in subdivisions 24-32	Benthic	3	2021	PA	?	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
sol.27.20-24	Sole in subdivisions 20-24	Benthic	1	2020	MP	✓	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
spr.27.22-32	Sprat in Subdivisions 22-32	Pelagic	1	2021	MP	✓	✗	Maximum sustainable yield	✗	✓	✗	✓
								Precautionary approach	✓	✓	✓	✓

Table A2 List of those stocks in the Baltic Seas ecoregion in 2020 that do not have a full set of reference points.

Stock name	Stock description	Latin name	Fisheries guild	Data category	Assessment year	Advice category
bll.27.22-32	Brill in subdivisions 22-32	*Scophthalmus rhombus*	Benthic	3.2	2020	PA/Stock status only
tur.27.22-32	Turbot in Subdivisions 22-32	*Scophthalmus maximus*	Benthic	3.2	2021	PA/Stock status only

Table A3 Scientific names of species.

Common name	Scientific name
Brill	*Scophthalmus rhombus*
Cod	*Gadus morhua*
Dab	*Limanda limanda*
European eel	*Anguilla anguilla*
Flounder	*Platichthys flesus*
Herring	*Clupea harengus*
Plaice	*Pleuronectes platessa*
Sole	*Solea solea*
Sprat	*Sprattus sprattus*
Turbot	*Scophthalmus maximus*