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## 4.2 Baltic Sea Ecoregion – Fisheries overview

### 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 for 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 on cod, or on herring and sprat in the central Baltic Sea. Patterns of seabed habitat disturbance largely reflect the distribution of bottom-trawl fishing effort. A large and, for some species, probably unsustainable bycatch of seabirds occurs at times in the gillnet fisheries; these fisheries also catch individuals of the critically endangered Central Baltic population of 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 and hence 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. Fisheries in the Baltic Sea are focussed on a few major species.

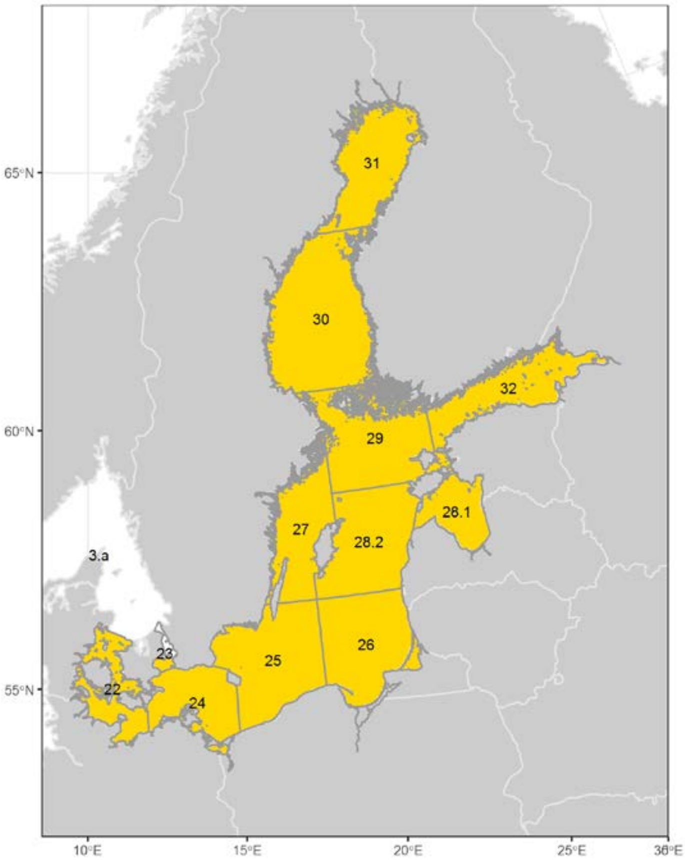



**Figure 1** The Baltic Sea ecoregion (highlighted in yellow). ICES Subdivision 23 is usually defined as part of the Greater North Sea ecoregion, but to be consistent with the current fisheries management regime, it is included in this overview.

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 country paragraphs highlight features of the fleets and fisheries of each country and 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. In the western Baltic Sea, a flatfish fishery exists targeting plaice which also catches turbot, dab, flounder, and brill. The coastal fisheries target species such as eel, flatfishes, and cod using mainly trapnets, poundnets, and gillnets and are prosecuted off all coasts and in the Belt area. Recreational fisheries target different species depending on the season with, cod, salmon, and trout being among the most important species. For cod, the main fishing area 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 30 fishing vessels (17–42 m), while the coastal fishery consists of several hundred small vessels of < 12 m. The pelagic fleet consists of stern trawlers mainly targeting herring and sprat in subdivisions 28.1, 28.2, 29, and 32. Trawlers also catch cod in subdivisions 25 and 26. About 25–30% of the herring catch is taken in coastal fisheries, mainly in the Gulf of Riga (Subdivision 28.1) and the Gulf of Finland (Subdivision 32) using trapnets and poundnets. 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 around 3200 vessels, of which almost 1500 vessels are actively used in the fishery. The vast majority of the vessels are < 12 m and operate in coastal fisheries. The offshore fleet is composed of 64 vessels between 12 and 40 m in the Baltic main basin, the Archipelago Sea, the Gulf of Bothnia, and the Gulf of Finland and mainly targets Baltic herring stocks (with sprat taken mainly as bycatch) with pelagic trawls. Occasionally, offshore vessels will fish for cod using bottom trawls in the southern Baltic. The coastal fisheries occur on all parts of the coast using trapnets, fykenets, and gillnets, and catch salmon, whitefish, pikeperch, perch, pike, vendace, burbot, and occasionally flounder and turbot. Recreational fisheries target mainly perch, pike, pikeperch, whitefish, bream, and herring using gillnets, rods, fish traps, and fykenets along the coast of Gulf of Finland and 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 50:50. 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 >12 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 gillnets but also trammelnets. 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 161 000 fishers, from all German shores and from boats (charter and private boats) mostly within 5 nautical miles (NM) of the coast and 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, and cod and flounder in subdivisions 25 and 26 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, smelt, round goby, salmon, sea trout, vimba bream, turbot, eelpout, flounder, 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 2016 comprised 25 offshore vessels (>18 m) and 64 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 principal species sought are sprat, herring, cod, and flounder mainly in subdivisions 25, 26, and 28 and to a lesser extent in subdivisions 27 and 29. The coastal fisheries target herring, smelt, flounder, turbot, and cod using gillnets and trapnets along all Lithuanian coasts (Subdivision 26). Recreational fisheries also occur in these waters and focus on cod, herring, salmon, and sea trout using hooks and trolls.

**Poland**

The fishing fleet consists of around 180 active offshore vessels (12–35 m) and approximately 630 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 97% of the total annual landings. The coastal fisheries harvest salmon, trout, turbot, plaice, eel, roach, perch, bream, pikeperch, whiting, whitefish, razorfish, crucian carp, and garfish. Recreational fisheries mostly target cod and salmon primarily along the central Polish coast and off the Hel Peninsula.

**Russia**

The fishing fleet is composed of 53 vessels divided into 44 offshore vessels (25–31 m) and nine coastal vessels (15–25 m). In subdivision 26 the small vessel fleet MRTK targets sprat and herring while the demersal trawl fleet (< 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 fisheries targeting cod, flounder, turbot, and salmon occur around the entire Russian coastline.

**Sweden**

The fleet is comprised of around 20 offshore vessels (around 10 vessels >40 m) and around 550 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 flatfishes 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.

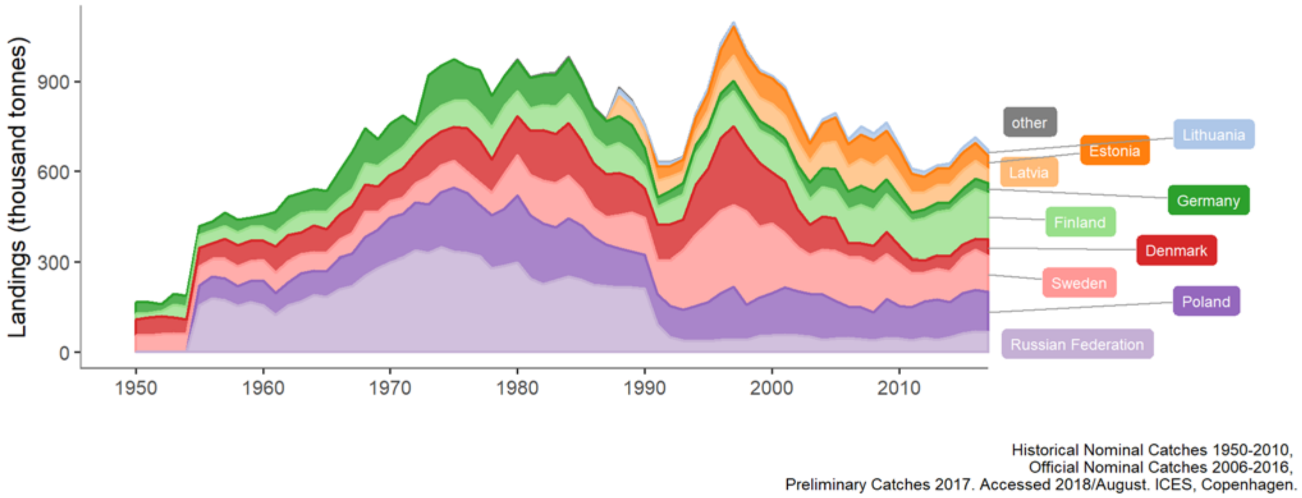



**Figure 2** Landings (thousand tonnes) from the Baltic Sea in 1950–2017, by (current) country. The nine countries having the highest landings are displayed separately and the remaining countries are aggregated and displayed as "other".

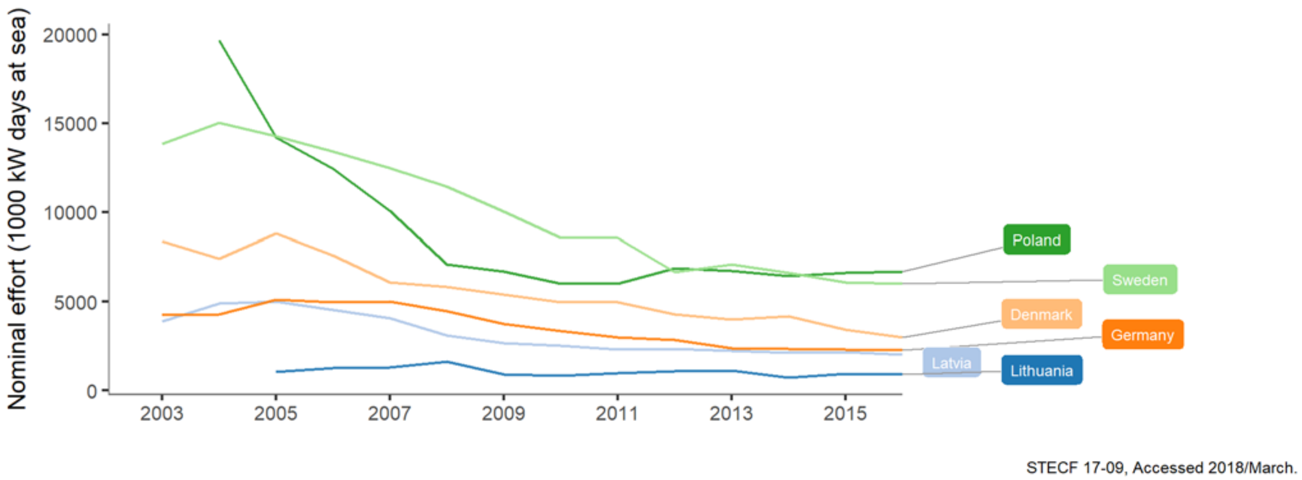



**Figure 3** Baltic Sea fishing effort (thousand kW days at sea) in 2003–2016, by EU nation. There is uncertainty about the effort data available for Finland and Estonia, so fishing effort for these two countries have been omitted from the figure.

## 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 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 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 the ICES assessments of the western Baltic cod and the Baltic salmon stocks. Estimated annual recreational catch of western cod has been relatively stable at around 2500 tonnes (only German data available), while estimated annual recreational catches of salmon have been more variable. There may also be significant recreational catches of trout, but these have yet to be quantitatively evaluated or included in the stock assessment. Recreational fishery surveys have been conducted in the Baltic; however, only few data for other species are available and these have not been used in assessments for the whole Baltic Sea.

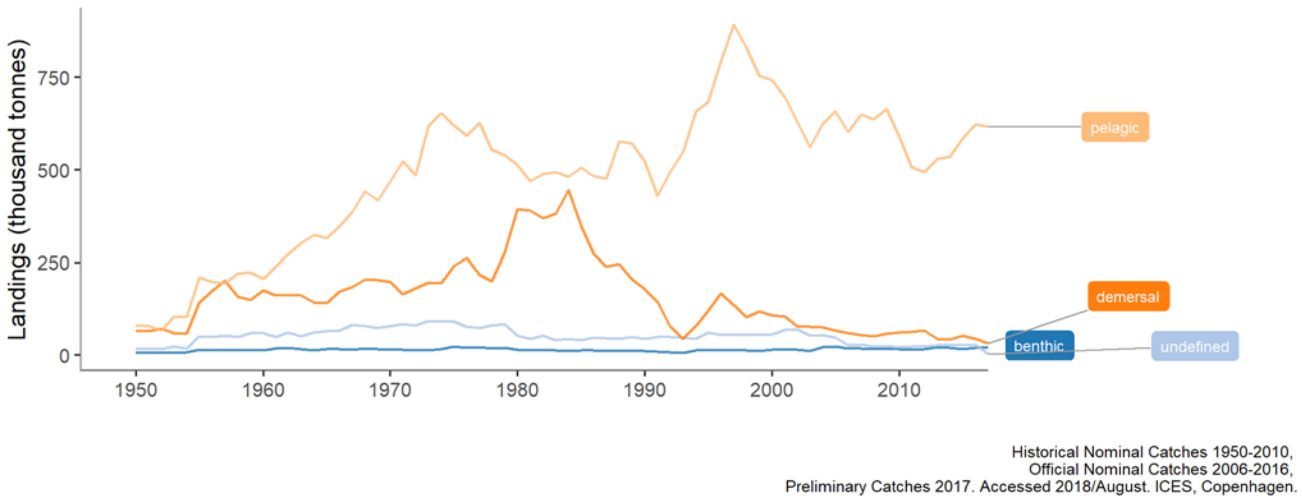



**Figure 4** Landings (thousand tonnes) from the Baltic Sea in 1950–2017, by fish category. Table 1 in the Annex details which species belong to each fish category.

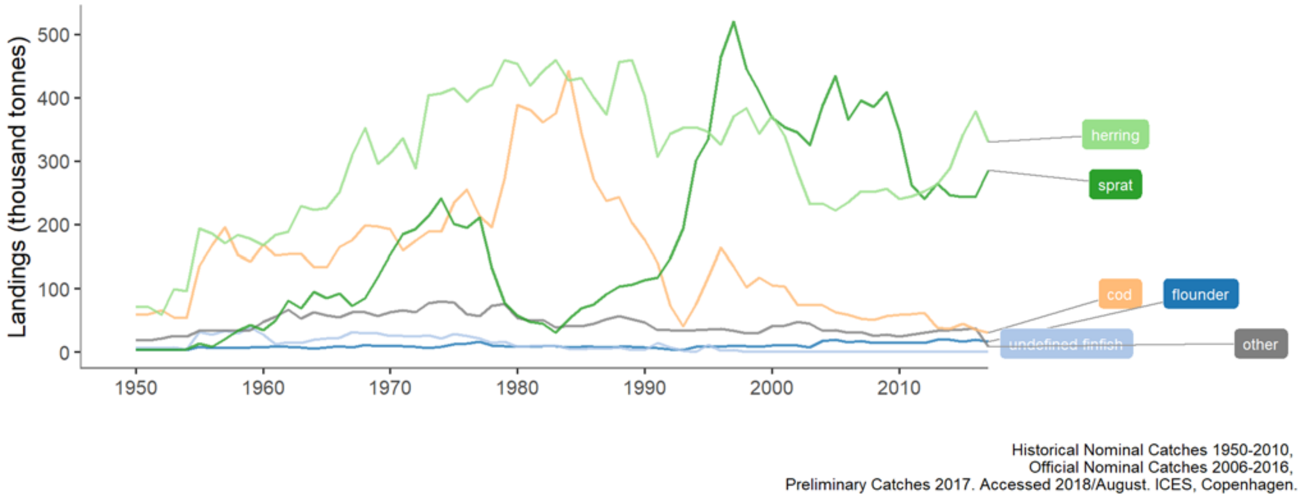



**Figure 5** Landings (thousand tonnes) from the Baltic Sea in 1950–2017, by species. The five species having the highest landings are displayed separately; the remaining species are aggregated and labelled as "other". The "undefined finfish" category is due to inadequate reporting in early years.

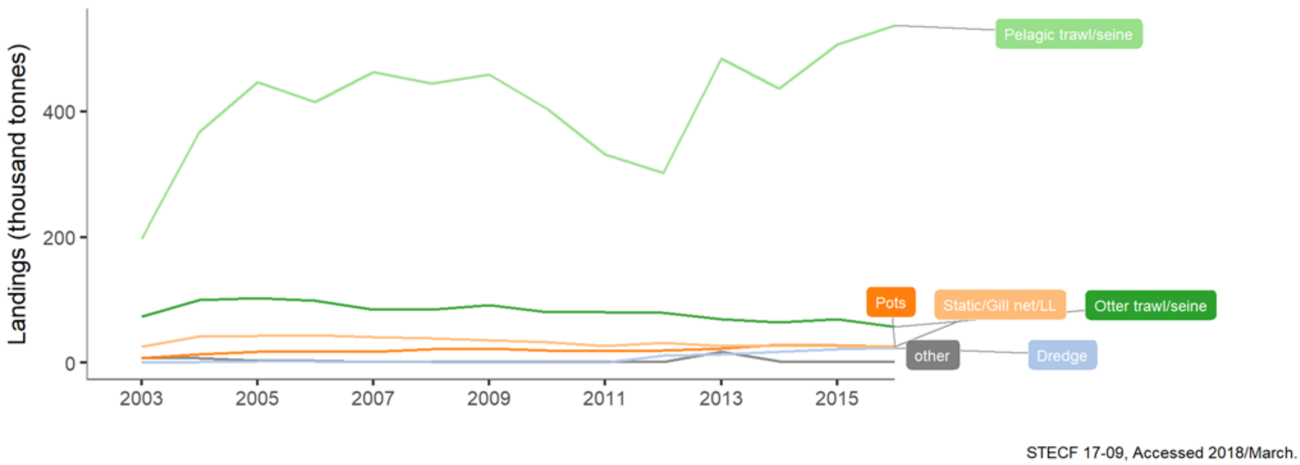



**Figure 6** Commercial landings (thousand tonnes) from the Baltic Sea in 2003–2016, by gear type (LL = longline). There is an error in the STECF database in 2013 for one country for pots and static gear; the landings from this gear by this country are omitted from the figure.

**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. A rise in benthic discard rates in 2014 is due to the inclusion of flounder stocks in the evaluation, which significantly increased the number of stocks assessed for discards (from 4 to 7 stocks). Demersal discards show a nominal overall decrease in 2015 because the of obligation to land all commercial catches of cod, salmon, herring, and sprat in the Baltic Sea that came into force in 2015. 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 for some species but further studies are needed.

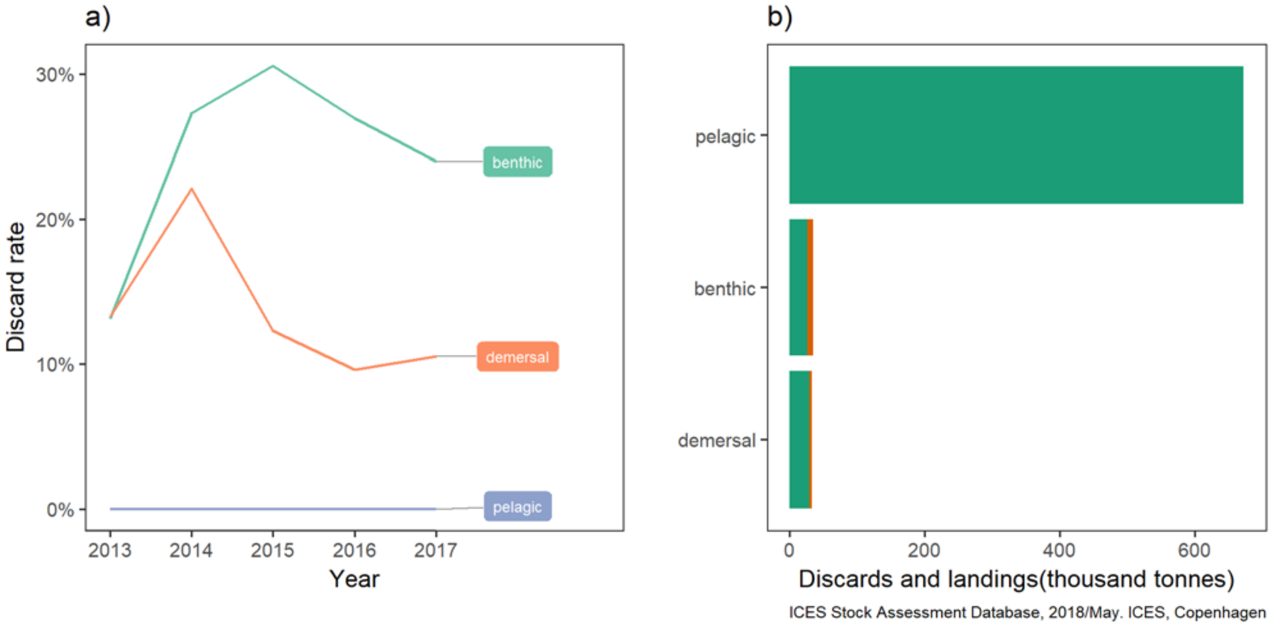



**Figure 7** Left panel (a): Discard rates in 2013–2017 by fish category, shown as percentages (%) of the total annual catch in that category. Right panel (b): Landings (green) and discards (orange) in 2017 by fish category (in thousand tonnes).

## Description of the fisheries

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).

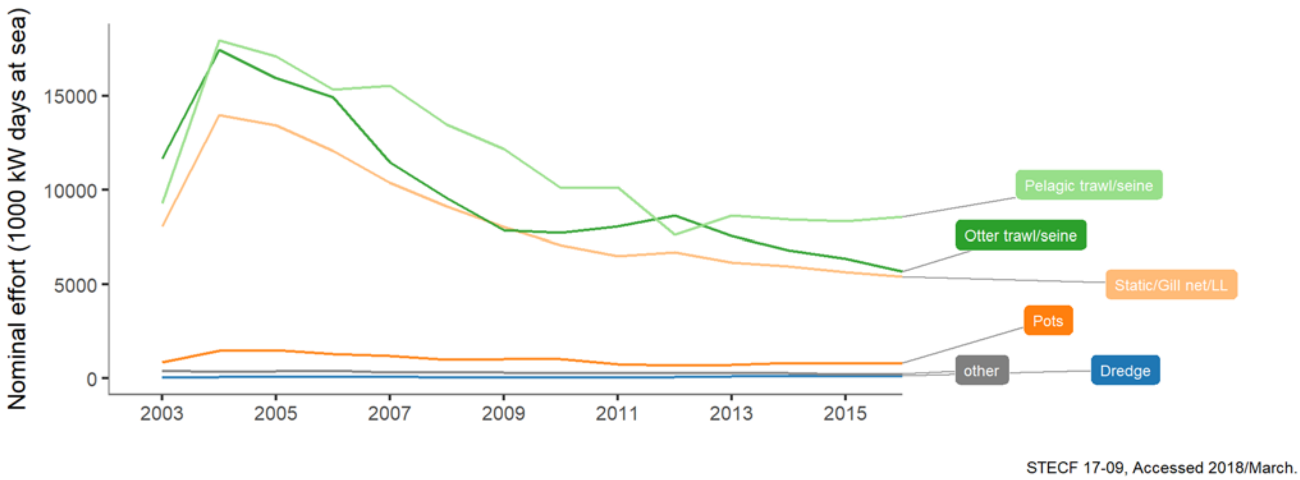



**Figure 8** Baltic Sea fishing effort (thousand kW days at sea) in 2003–2016 by EU vessels (except those of Finland and Estonia, see Figure 3), by gear type.

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.

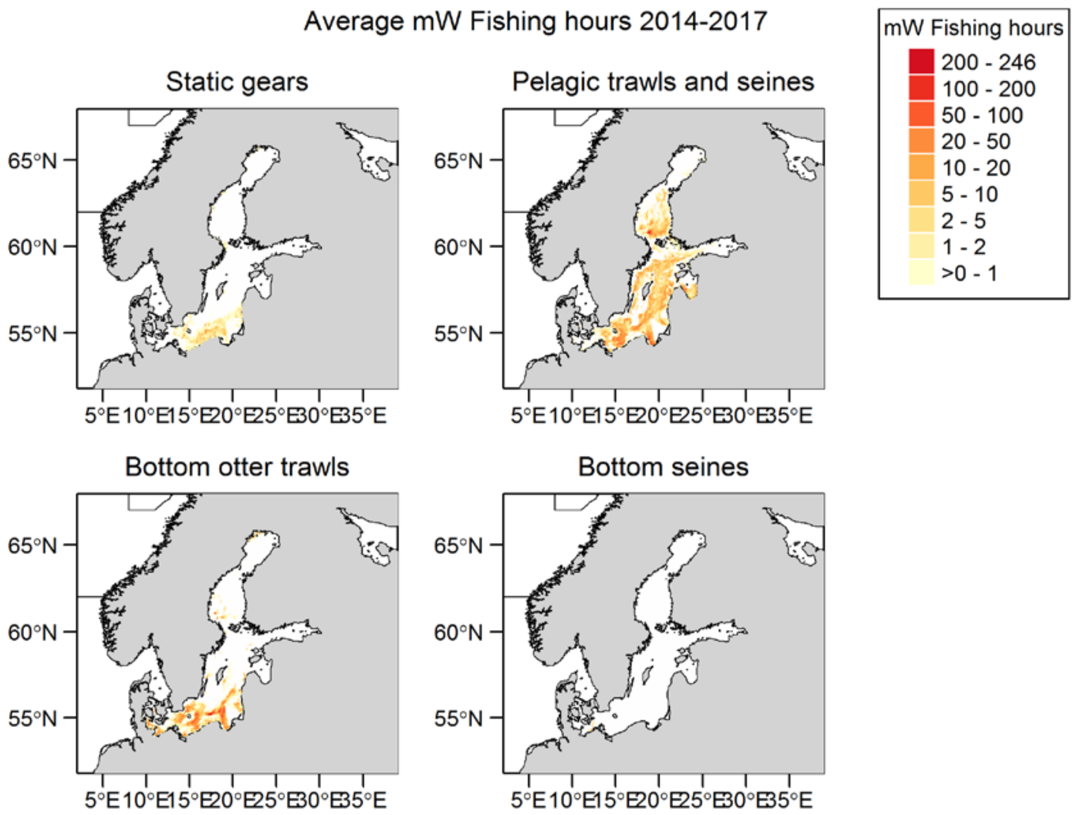



**Figure 9** Spatial distribution of average annual fishing effort (mW fishing hours) in the Baltic Sea during 2014–2017, by gear type. Fishing effort data are only shown for vessels >12 m having vessel monitoring systems (VMS).

**Bottom trawl and seine**

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.

**Gillnet**

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 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 not evaluated or included in the stock assessments. However, for salmon and western Baltic cod recreational catches are significant and are included in the ICES assessments of the stocks. Very few countries have assessed the numbers of recreational fishers.

## Fisheries management

Baltic Sea fisheries management is under the EU’s Common Fisheries Policy (CFP) and Russian 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 in 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% despite the fact that the EU landing obligation has been in place since 2015. Fishing mortality on western Baltic cod was much too high for the last 19 years, in spite of a management plan 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 for improving spawning conditions by for example avoiding disruption of spawning aggregations). In 2016, STECF evaluated revised spawning closures and concluded that the spatial closure appeared 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. A small majority of the Baltic stocks that are analytically assessed (category 1) are fished at rates at or above $F_{MSY}$ (Figure 10), also according to the EU Marine Strategy Framework Directive (MSFD) D3C1 and good environmental status (GES) boundaries. However, most of the stocks are fished within the D3C2 boundaries that considers 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 majority of the landings is from stocks with full reproductive capacity, which is largely driven by landings of sprat and herring in subdivisions 25–29 and 32, excluding the Gulf of Riga (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 eastern and western cod, herring stocks in the Gulf of Bothnia, in the central Baltic, and in the western Baltic, as well as sprat in the Baltic Sea and sole *(Solea solea*) in subdivisions 20–24. Annex 1 contains a full list of the stocks included in these figures.

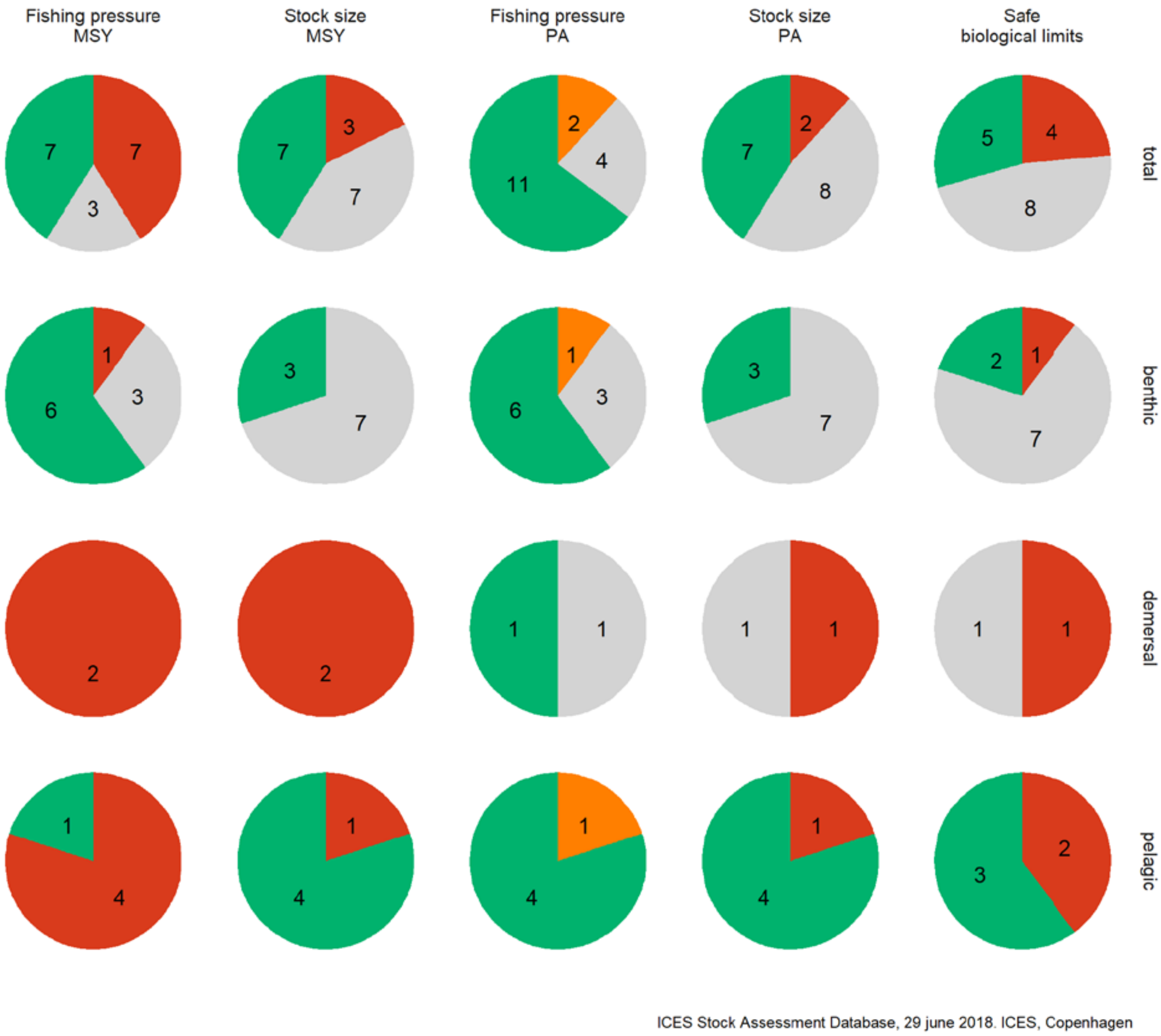
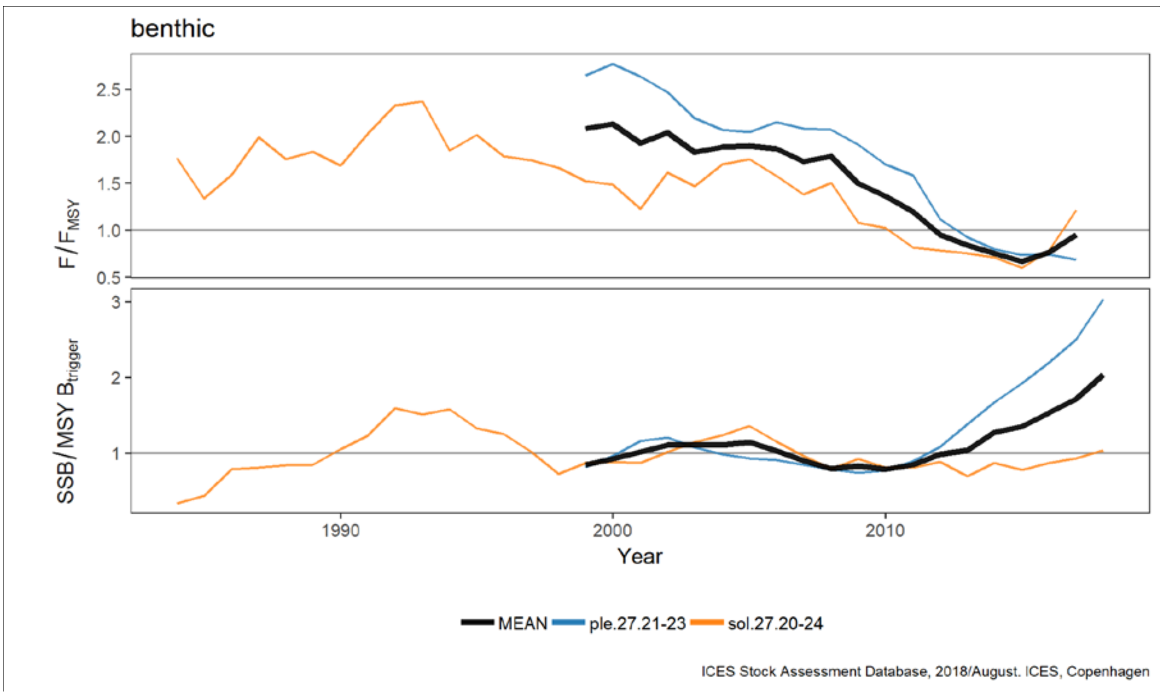
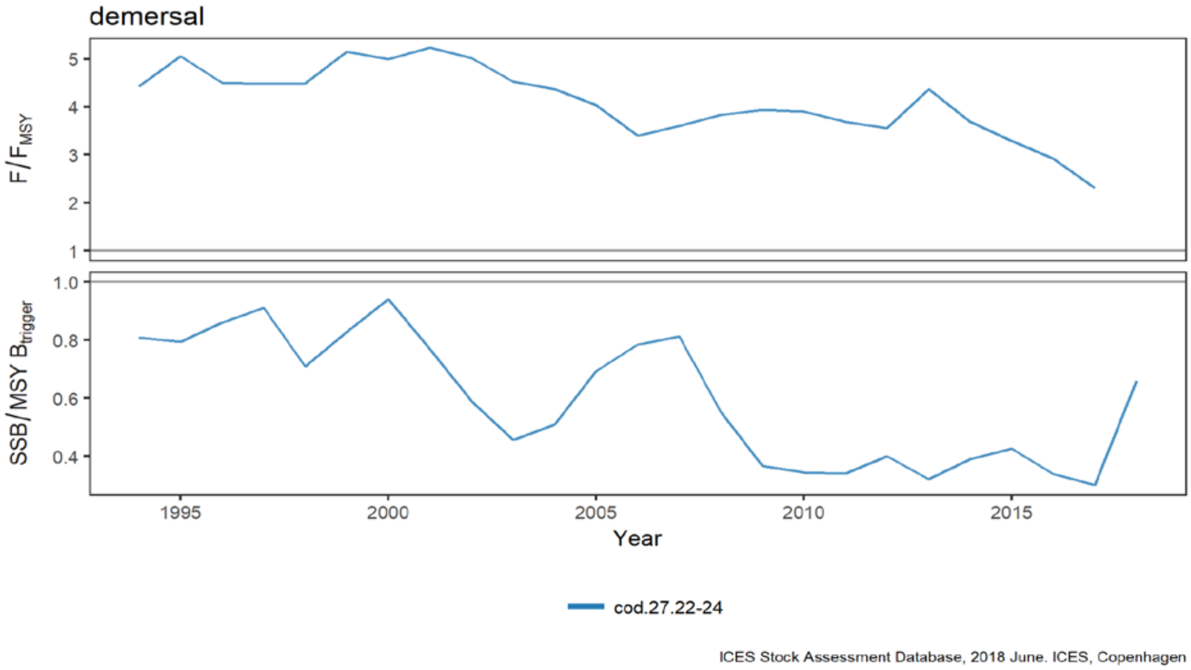



**Figure 10** Status summary of Baltic Sea stocks in 2018 relative to the ICES maximum sustainable yield (MSY) approach and precautionary approach (PA) (excluding European eel, salmon, and sea trout). Grey represents unknown reference points. *For the MSY approach*: green represents a stock that is fished below $F_{MSY}$ or the stock size is greater than MSY $B_{trigger}$; red represents a stock status that is fished above $F_{MSY}$ or the 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 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. If this condition is not fulfilled the stock is defined as being outside safe biological limits. For stock-specific information, see Table A in Annex 1.


**Figure 11** Status summary of Baltic Sea stocks in 2018 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 fished below $F_{MSY}$ or the stock size is greater than MSY $B_{trigger}$, for criteria D3C1 and D3C2. Red represents the proportion of stocks fished above $F_{MSY}$ or where the 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 A in Annex 1.





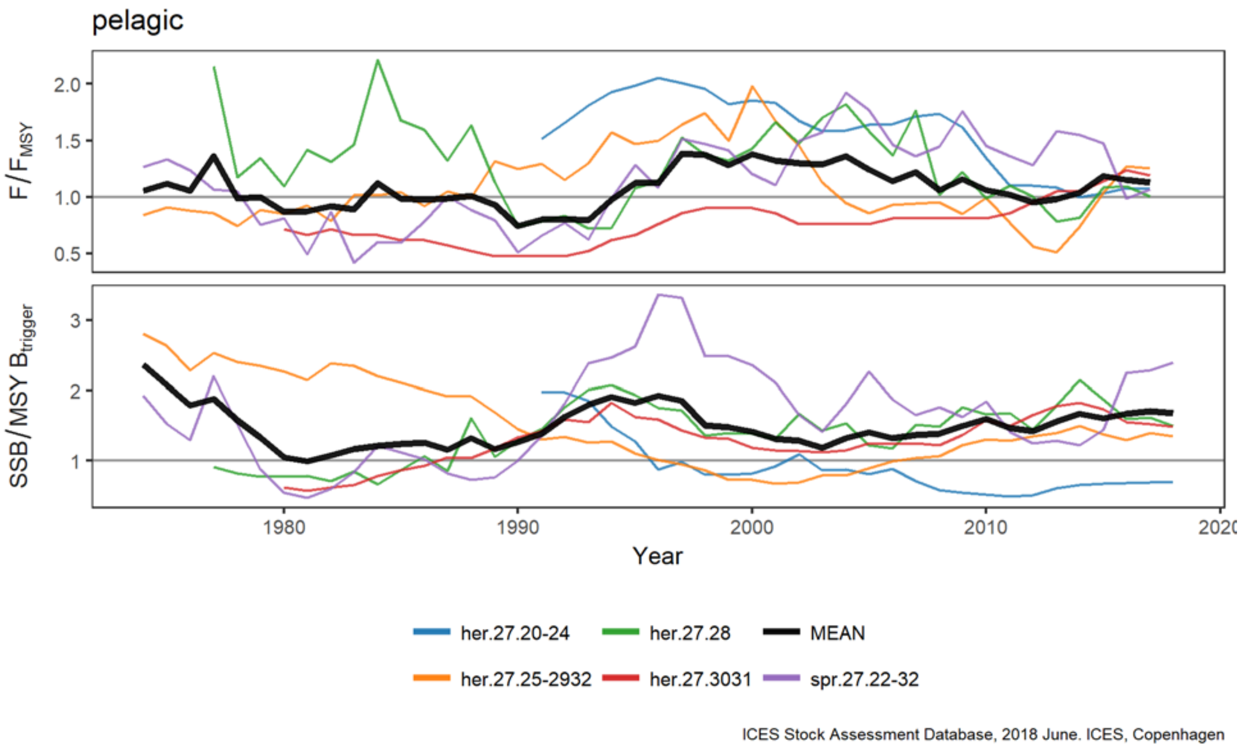
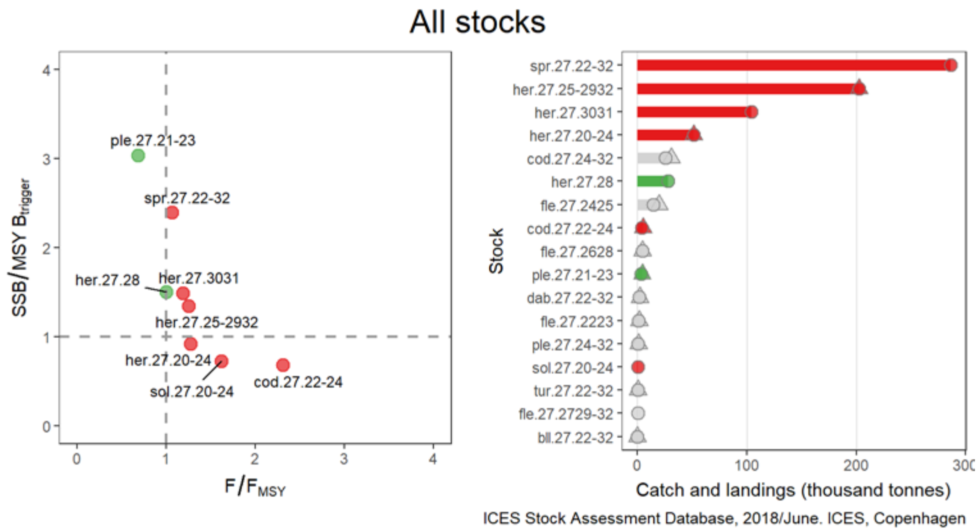
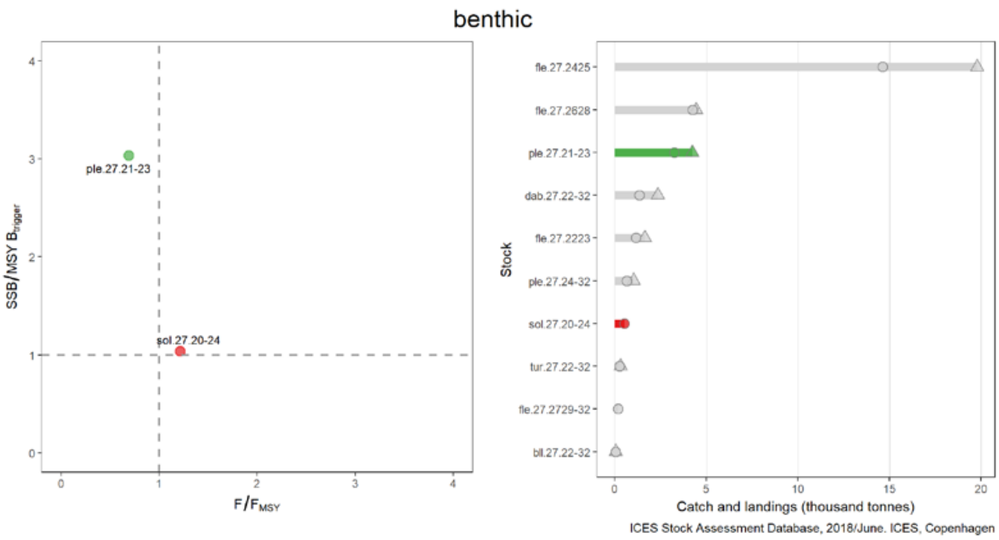




**Figure 12** Temporal trends in $F/F_{MSY}$ and SSB/MSY $B_{trigger}$ for Baltic Sea benthic, demersal, and pelagic stocks. Only stocks with defined MSY reference points are considered. For full stock names, see Table A in Annex 1.


All stocks
SSB/MSY B_trigger
F/F_MSY
ple.27.21-23
spr.27.22-32
her.27.28
her.27.3031
her.27.25-2932
her.27.20-24
sol.27.20-24
cod.27.22-24
Stock
spr.27.22-32
her.27.25-2932
her.27.3031
her.27.20-24
cod.27.24-32
her.27.28
fle.27.2425
cod.27.22-24
fle.27.2628
ple.27.21-23
dab.27.22-32
fle.27.2223
ple.27.24-32
sol.27.20-24
tur.27.22-32
fle.27.2729-32
bll.27.22-32
Catch and landings (thousand tonnes)
ICES Stock Assessment Database, 2018/June. ICES, Copenhagen


benthic
SSB/MSY B_trigger
F/F_MSY
ple.27.21-23
sol.27.20-24
Stock
fle.27.2425
fle.27.2628
ple.27.21-23
dab.27.22-32
fle.27.2223
ple.27.24-32
sol.27.20-24
tur.27.22-32
fle.27.2729-32
bll.27.22-32
Catch and landings (thousand tonnes)
ICES Stock Assessment Database, 2018/June. ICES, Copenhagen

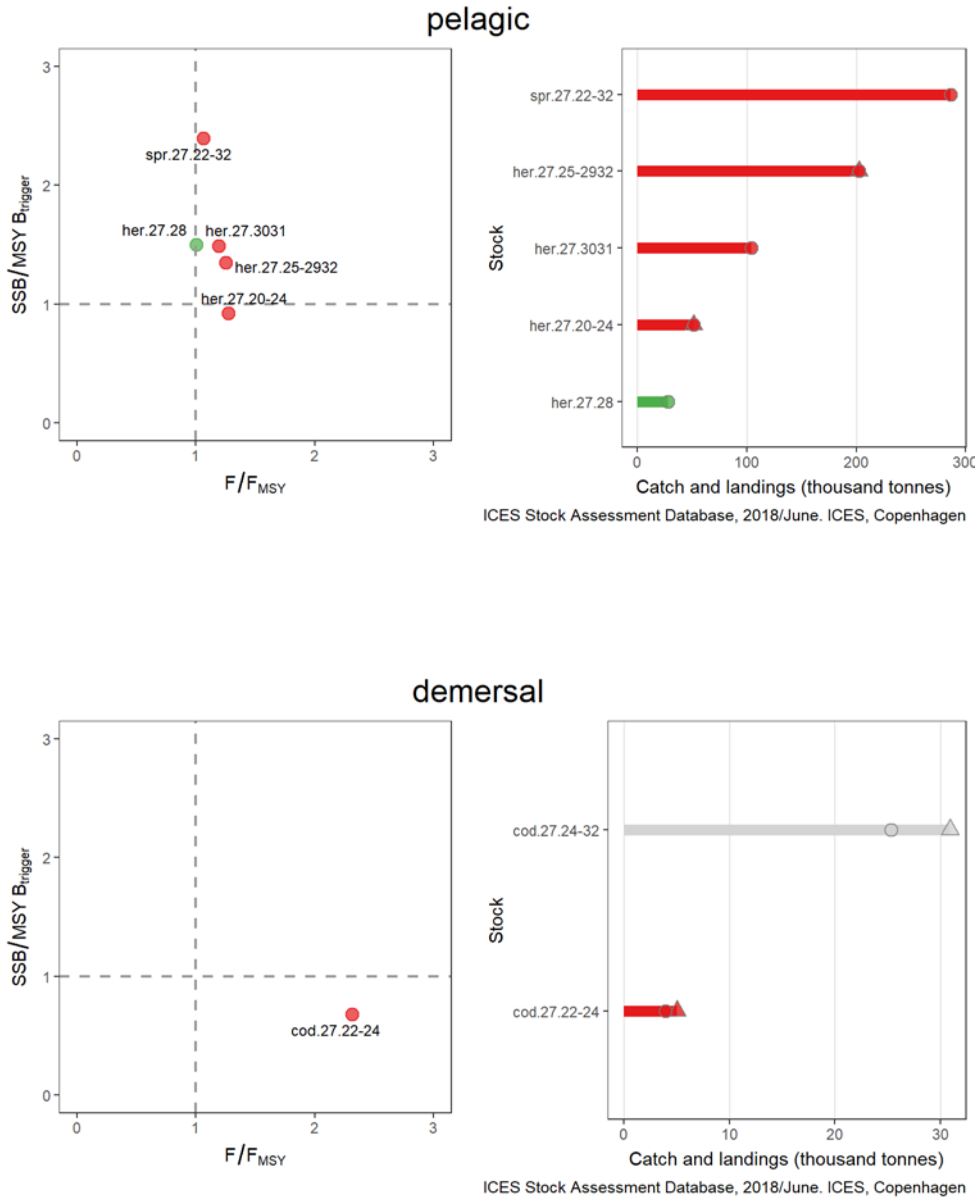



**Figure 13** Status of Baltic Sea stocks relative to the joint distribution of exploitation ($F/F_{MSY}$) and stock size ($SSB/\ MSY\ B_{trigger}$) [left panels, by individual stocks] and catches (triangles) / landings (circles) from these stocks in 2018 [right panels]. The left panels only include 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. For full stock names, see Table A in Annex 1.

## Mixed fisheries

Many fishing gears catch more than one species at the same time, so "technical interactions" occur between stocks when multiple species are captured in the same gear during fishing operations. Because these interactions may vary through time and space (e.g. interactions might vary between day and night, or between different times of year, or between different areas), it would be ideal for them to 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, and some 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 landing of the fisheries. A high proportion of the catches of herring was for example taken in fisheries where herring landings where at least 5% of the total landings while the amount of herring in fisheries where sprat accounts for at least 5% of the total landings was medium. The amounts of sprat were high in both the fisheries where herring or sprat accounted for at least 5% of the total catch.

The columns illustrates 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 amount 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.

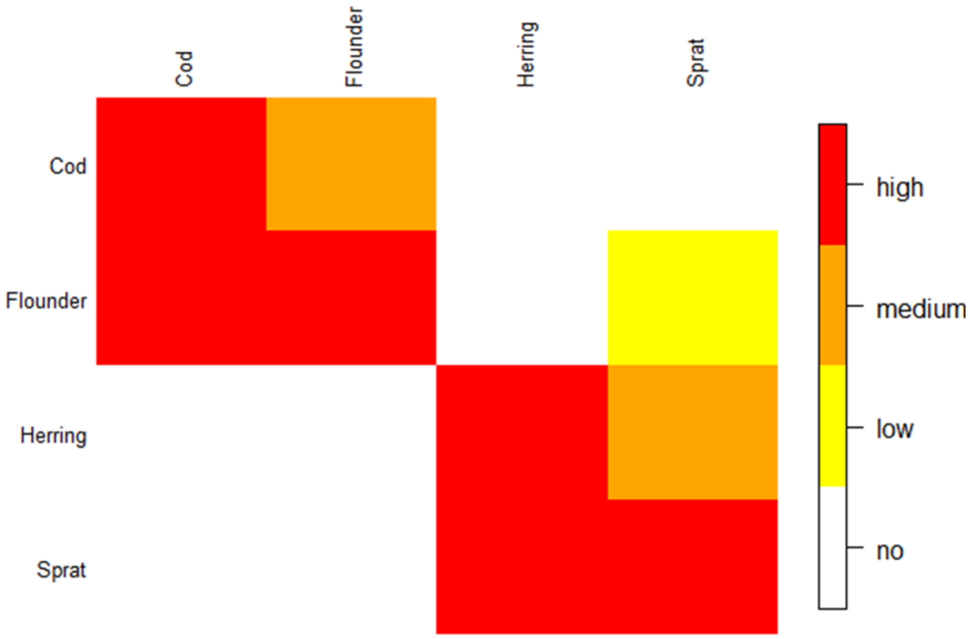



**Figure 14** Technical interactions between the four most important stocks in the Baltic Sea. The rows of the figure illustrate the fisheries where the species A was caught. Red cells indicate the species B which the A species are frequently caught together with. Orange cells indicate medium interactions and yellow cells indicate weak interactions. The column shows the degree of mixing in fisheries where species B account for at least 5% of the total landings. A more detailed explaination of the figure 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 very variable degree of mixing in the catches of sprat and herring. The degree of mixing varies on a spatial scale (Figure 15). According to logbooks and sales slips, the mixing can vary between < 5% to 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 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 is mainly in the central part of the Baltic. 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 mixture of herring and sprat as the directed herring fishery. There is, however, a low spatial overlap of the directed herring and sprat fishery reported.

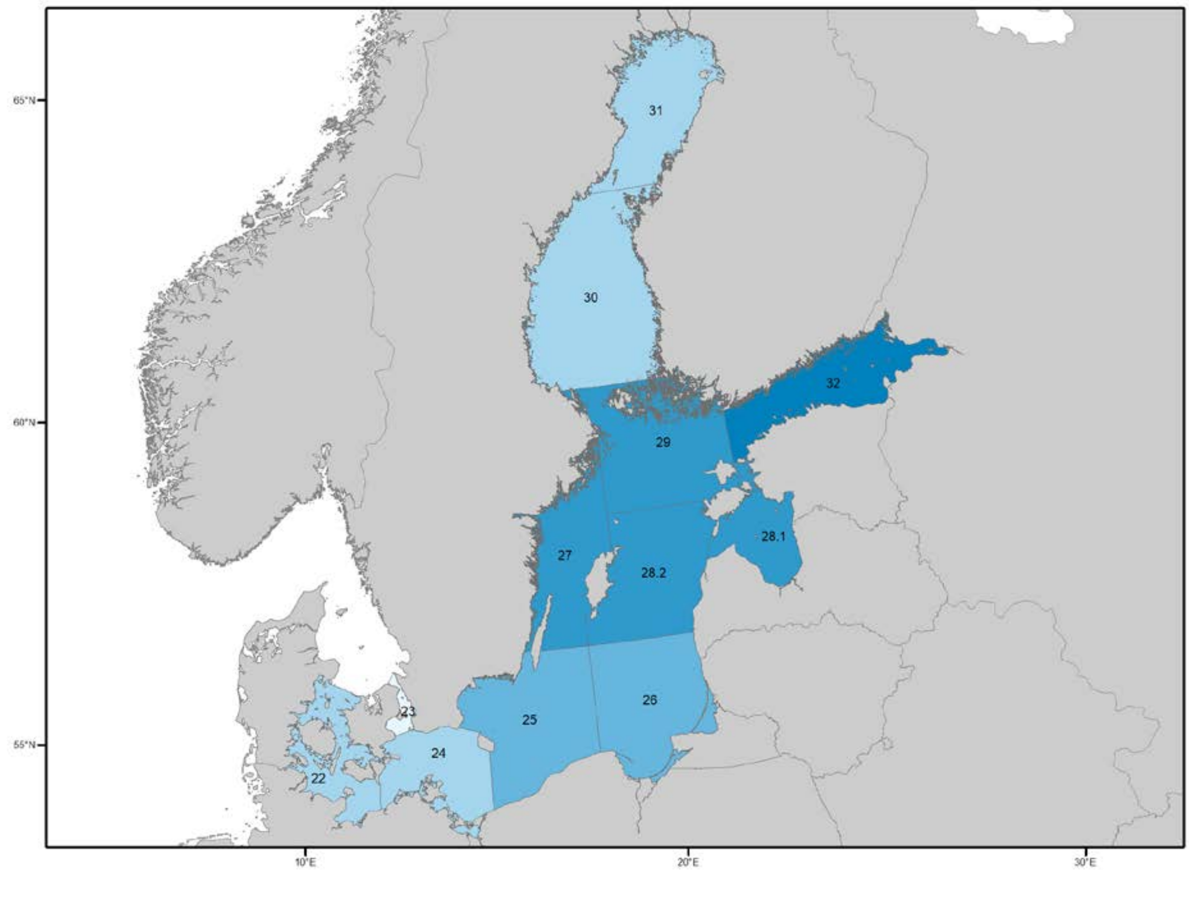



**Figure 15** Spatial variation in reported mixing of herring and sprat in trawl fishery in the Baltic. Darker colour indicates higher mixing.

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 1st and the 4th year quarters, in particular in the northern Baltic Sea; the 1st and 4th quarters are also the main fishing seasons.

The coastal fisheries with smaller vessels targeting herring with gillnets and trap-nets 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.

There is no mixed fisheries advice developed yet for the Baltic Sea.

## Species interaction

The 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.

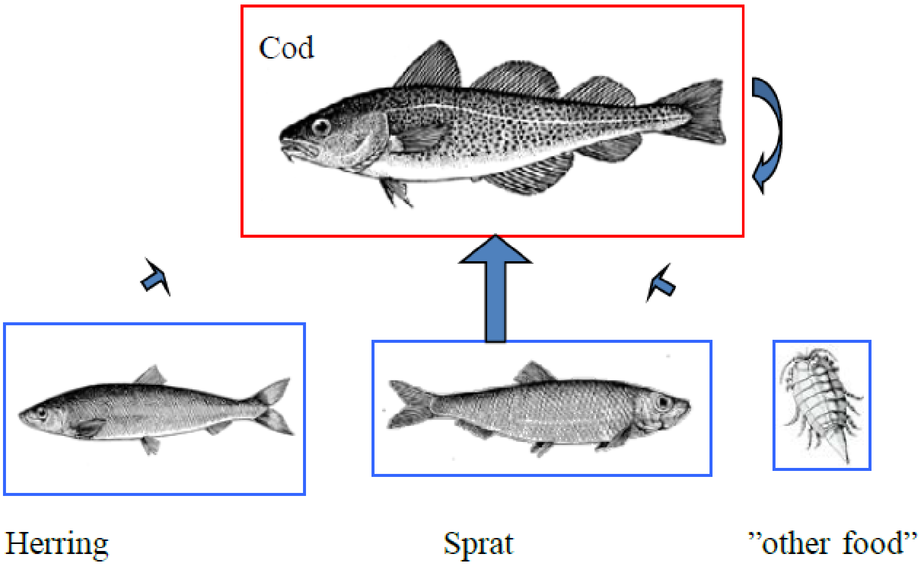



**Figure 16** The main Baltic Sea foodweb.

In the Baltic, 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 great survival and growth 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.

Differences in the distributions of cod and herring and sprat imply that an increase in eastern cod landings will not necessarily result in a major increase in herring and sprat stock sizes (and hence catching opportunities). A reduction of herring and sprat landings in the central Baltic Sea is likely to have a positive impact on growth and condition of cod, and perhaps also reduce cod cannibalism. An increase in herring and sprat landings in the northeastern Baltic areas (subdivisions 27–32) is unlikely to negatively affect the eastern cod stock but may have a positive impact on the growth rates of herring and sprat.

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, and the total biomass of sprat in the Baltic main basin and salmon growth are positively correlated. A large sprat stock may have a positive impact on salmon growth but may also 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).

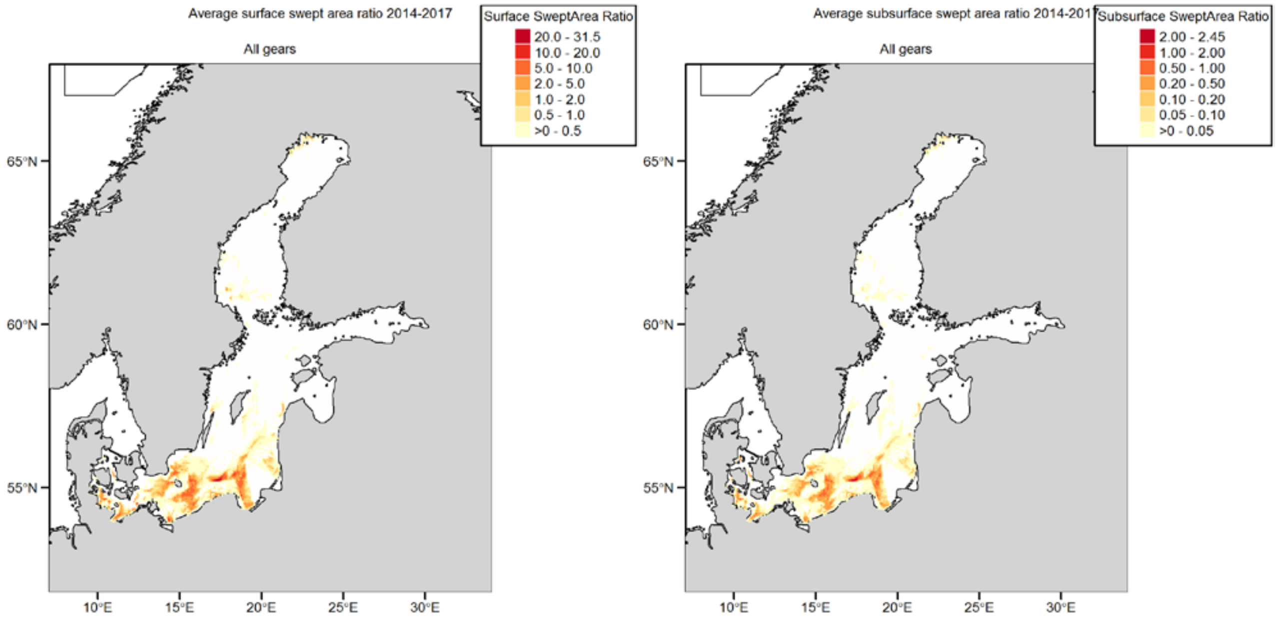



**Figure 17** Average annual surface (left) and subsurface (right) disturbance by mobile bottom-contacting fishing gear (bottom otter trawls, bottom seines, beam trawls) in the Baltic Sea during 2014–2017, expressed as average swept-area ratios (SAR). No data from Russia are included as none were supplied.

Fishing gear disturbances of bottom substrates inflict damage to benthic communities, but little is known at the regional scale about the sensitivity of different Baltic Sea organisms and communities to these fishery-induced impacts. A qualitative approach to address this was elaborated by ICES in 2016. A mechanistic, quantitative assessment procedure based on biological principles is now under development. These approaches would be improved with further research and evidence to better parameterize models, as well as by establishing better quantitative links to other pressures (e.g. anoxia). Secondary effects of bottom trawling include smothering and resuspension of sediment and nutrients, as well as foodweb effects, but these are difficult to evaluate compared to primary effects.

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 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 consequential decline in sea duck populations. Birds that actively pursue their prey underwater were more susceptible than those that graze on the benthos. For at least four bird species, this mortality was sufficiently high to generate declines in population abundance and be unsustainable.

The abundance of both ringed seal and harbour porpoise populations in the central Baltic Sea are very low, having been depleted (for uncertain reasons) in the past. Any fisheries bycatch of these populations is detrimental, but documenting such bycatch is difficult at sea. Dead harbour porpoises exhibiting evidence of gillnet entanglements are found and reported regularly, so it is likely that bycatch in gillnets is adversely affecting the critically endangered central Baltic Sea population.

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## Annex

Supporting data used in the Baltic Sea Fisheries overview is archived at ICES (2018).

The following annex table is a status summary of the Baltic Sea stocks in 2018.

**Table A1** Status summary of Baltic Sea stocks in 2018 relative to maximum sustainable yield (MSY) and the ICES precautionary approach (PA) (excluding salmon and trout). Grey represents unknown reference points. Reference points for European eel are qualitative. Reference points for sole are valid until end of June and are updated after the North Sea advice release each year. 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. SBL = Safe Biological Limits; MSFD = EU Marine Strategy Framework Directive; D3C1 = MSFD indicator for fishing mortality; D3C2 = MSFD indicator for spawning-stock biomass; GES = good environmental status.

| Stock code and name | Fish category | Reference point | Data category | SBL | Fishing pressure | | | Stock size | | | MSFD descriptor | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2015 | 2016 | 2017 | 2016 | 2017 | 2018 | D3C1 | D3C2 | GES |
| bll.27.22-32 Brill in subdivisions 22–32 (Baltic Sea) | benthic | PA | 3 | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| cod.27.22-24 Cod in subdivisions 22–24, western Baltic stock (western Baltic Sea) | demersal | MSY | 1 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| cod.27.24-32 Cod in subdivisions 24–32, eastern Baltic stock (eastern Baltic Sea) | demersal | MSY | 3 | ? | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ |
| dab.27.22-32 Dab in subdivisions 22–32 (Baltic Sea) | benthic | MSY | 3 | ? | ✓ | ✓ | ✓ | ? | ? | ? | ✓ | ? | ? |
| ele.2737.nea European eel throughout its natural range | demersal | PA | 3 | ? | ? | ? | ? | ✗ | ✗ | ✗ | ? | ✗ | ✗ |
| fle.27.2223 Flounder in subdivisions 22 and 23 (Belt Seas and the Sound) | benthic | MSY | 3 | ? | ✓ | ✓ | ✓ | ? | ? | ? | ✓ | ? | ? |
| fle.27.2425 Flounder in subdivisions 24 and 25 (west of Bornholm and southwestern central Baltic) | benthic | MSY | 3 | ? | ✓ | ✓ | ✓ | ? | ? | ? | ✓ | ? | ? |
| fle.27.2628 Flounder in subdivisions 26 and 28 (east of Gotland and Gulf of Gdansk) | benthic | PA | 3 | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| fle.27.2729-32 Flounder in subdivisions 27 and 29–32 (northern central and northern Baltic Sea) | benthic | MSY | 3 | ? | ✓ | ✓ | ✓ | ? | ? | ? | ✓ | ? | ? |

| Stock code and name | Fish category | Reference point | Data category | SBL | Fishing pressure | | | Stock size | | | MSFD descriptor | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2015 | 2016 | 2017 | 2016 | 2017 | 2018 | D3C1 | D3C2 | GES |
| her.27.20-24 Herring in subdivisions 20–24, spring spawners (Skagerrak, Kattegat, and western Baltic) | pelagic | MSY | 1 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| her.27.25-2932 Herring in subdivisions 25–29 and 32, excluding the Gulf of Riga (central Baltic Sea) | pelagic | MSY | 1 | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ |
| her.27.28 Herring in Subdivision 28.1 (Gulf of Riga) | pelagic | MSY | 1 | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| her.27.3031 Herring in subdivisions 30 and 31 (Gulf of Bothnia) | pelagic | MSY | 1 | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ |
| ple.27.21-23 Plaice in subdivisions 21–23 (Kattegat, Belt Seas, and the Sound) | benthic | MSY | 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ple.27.24-32 Plaice in subdivisions 24–32 (Baltic Sea, excluding the Sound and Belt Seas) | benthic | MSY | 3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| sol.27.20-24 Sole in subdivisions 20–24 (Skagerrak and Kattegat, western Baltic Sea) | benthic | MSY | 1 | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ |
| spr.27.22-32 Sprat in subdivisions 22–32 (Baltic Sea) | pelagic | MSY | 1 | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ |
| tur.27.22-32 Turbot in subdivisions 22–32 (Baltic Sea) | benthic | PA | 3 | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? |

**Table A2** Scientific names of species.

Blue mussels *Mytilus edulis*
Bream *Abramis brama*
Brill *Scophthalmus rhombus*
Burbot *Lota lota*
Cod *Gadus morhua*
Crucian carp *Carassius carassius*
Dab *Limanda limanda*
Eelpout *Zoarces viviparus*
(European) eel *Anguilla anguilla*
Flounder *Platichthys flesus*
Garfish *Belone belone*
Harbour porpoise *Phocoena phocoena*
Herring *Clupea harengus*
Perch *Perca fluviatilis*
Pike *Esox lucius*
Pikeperch *Sander lucioperca*
Plaice *Pleuronectes platessa*
Razorfish *Ensis magnus*
Ringed seal *Pusa hispida*
Roach *Rutilus rutilus*
Round Goby *Neogobius melanostomus*
Salmon *Salmo salar*
(European) Smelt *Osmerus eperlanus*
Sole *Solea solea*
Sprat *Sprattus sprattus*
(Sea) Trout *Salmo trutta*
Turbot *Scophthalmus maximut*
Vendace *Coregonus albula*
Vimba bream *Vimba vimba*
Whitefish *Coregonus maraena*
Whiting *Merlangius merlangus*