12.2 Norwegian Sea ecoregion – Fisheries overview

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Executive summary

The largest landings in this ecoregion are by Norway, the Russian Federation (Russia henceforth), Faroe Islands, and Iceland, mainly by pelagic fisheries. Other nations also have fisheries in the area. The number of fishing vessels is declining while the size of the remaining vessels is increasing. The annual catch in the ecoregion has varied between 700 000 tonnes to over 2 million tonnes.

The pelagic fisheries, using purse seine and pelagic trawls, account for the largest catches by weight and target Norwegian spring-spawning (NSS) herring (her.27.1-24a514a), blue whiting (whb.27.1-91214), mackerel (mac.27.nea), and other pelagic species. The largest demersal fishery targets cod (cod.27.1-2), haddock (had.27.1-2), and saithe (pok.27.1-2) using bottom trawls, purse seine, Danish seine and gillnets, and to a lesser extent hook and line gear. Smaller fisheries target other gadoid species, Greenland halibut (ghl.27.1-2), and beaked redfish (reb.27.1-2). Landings of pelagic species within the ecoregion in the last decades have been variable. The demersal fisheries, dominated by cod, display less pronounced fluctuations than the pelagic fisheries. Information about discards is sparse, but the total weight of discards is considered low in both the pelagic and the demersal fisheries. Harp seals and minke whales are hunted in the region.

Status summary of Norwegian Sea stocks relative to the ICES maximum sustainable yield (MSY) approach and precautionary approach (PA) is known for about 45% of the 22 stocks assessed by ICES in this ecoregion. Only 23% of the stocks are fished below F_{MSY}, accounting for nearly 14% of the total catch. 32% of the stocks have a biomass above MSY $B_{trigger}$, accounting for 69% of the total catch. Demersal stocks have shown a trend of declining fishing mortality since the mid-1990s, followed by a sharp increase in 2019, largely driven by the exploitation pattern of redfish. In 2020 the average F/F_{MSY} ratio was close to 1. The mean SSB/MSY $B_{trigger}$ ratio of demersal stocks has been decreasing over the last decade, but mean SSB remains above MSY $B_{trigger}$. The average F/F_{MSY} ratio for pelagic stocks has fluctuated around 1 since 2000 . The mean SSB/MSY $B_{trigger}$ ratio for pelagic species has shown a slight increase over the last two decades followed by a recent sharp decline, but it remains above 1.

In addition to biomass removal, ecosystem effects of fisheries include abrasion, ghost fishing, and bycatch of protected, endangered, and threatened species.

Introduction

The Norwegian Sea connects with the Faroes ecoregion to the southwest, the Icelandic Waters ecoregion and Greenland Sea to the west along the edge to the shallower Iceland Sea between the Faroe Islands, and northwards to Jan Mayen. To the South it borders to the shallower North Sea along the 62˚N parallel between Norway and the Faroe Islands, and to the northeast with the shallower Barents Sea (Figure 1). The Norwegian Sea covers more than 1.1 million km^2, consisting of two deep basins (between 3000 m and 4000 m deep), the Norwegian Basin and the Lofoten Basin, separated by the Vøring plateau (between 1000 m and 3000 m deep). The Norwegian Sea is separated from the Greenland Sea to the north by the Mohn Ridge. To the west, the basin slope forms the transition to the somewhat shallower Iceland Sea. The warm North Atlantic Current ensures relatively stable and high water temperatures, so that unlike the Arctic seas, the Norwegian Sea is ice-free throughout the year.

The Norwegian Sea ecoregion covers parts of ICES Subarea 2 and a small part of ICES Division 14.a. Fisheries statistics used in this overview are taken from the entire Subarea 2.

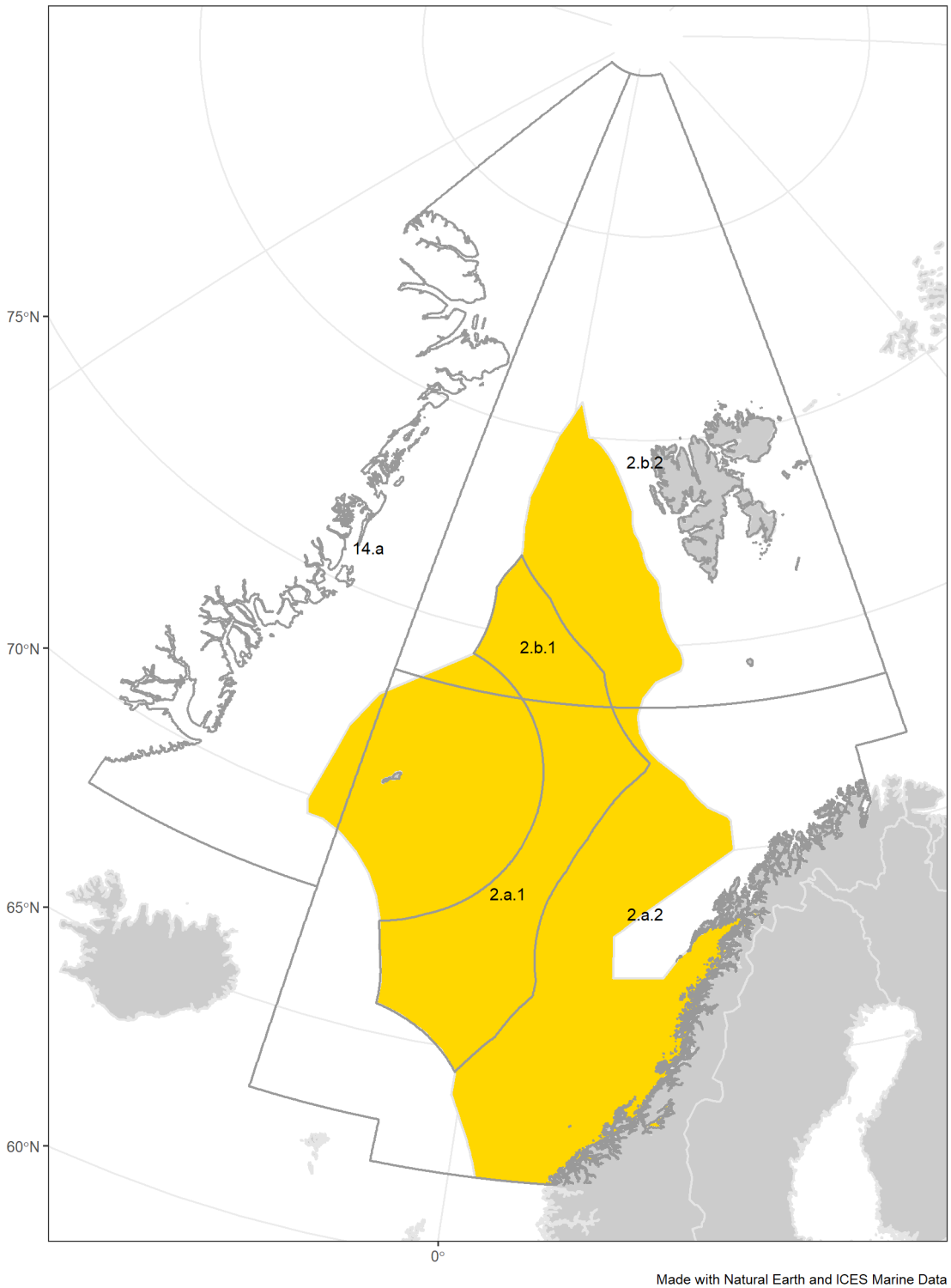


Figure 1 The Norwegian Sea ecoregion (highlighted in yellow) and ICES statistical areas.

The overview provides:

- a short description of each of the national fishing fleets in the ecoregion, including their 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; and
- an evaluation of the impacts of fishing gear on the ecosystem in terms of physical contact on subsurface and bottom habitats, and on the bycatch of protected species.

Scientific names of all species are included in Table A3 in the Annex.

Who is fishing

Many nations currently have fisheries targeting the marine stocks within this ecoregion. The largest landings are by Norway, Russia, Faroe Islands, and Iceland. Lesser amounts are landed by the United Kingdom and others (Figure 2). The largest nominal effort is by Norway (Figure 3). Pelagic fishing by multinational fleets is the major activity in the ecoregion. The number of fishing vessels is declining while the size of the vessels is increasing.

Norway

The Norwegian commercial fleet has the majority of its fishing activity in the shelf area, particularly along the coast of Norway and along the continental shelf edge. The Norwegian fleet fishing in the ecoregion consists of about 2300 active vessels fishing pelagic fish (mackerel and herring), demersal fish (cod, saithe, haddock, ling (lin.27.1-2), tusk (usk.27.1-2), Greenland halibut, and redfish), and shellfish (brown crab, king crab, and northern prawn). Small coastal vessels (the majority < 15 m length) fishing with beach seine, gillnets, and pots make up around 87% of the fleet, while the remaining are mainly ocean-going trawlers and purse seiners > 28 m in length. The highest catch volume (82% of the total catch) is taken by the bigger vessels, with pelagic fish constituting the largest part of the landings.

Harp and hooded seals are hunted with 2–5 large ice-going vessels. The minke whale hunt has been ongoing in all years since 1993. Approximately 10–15 vessels participate in the minke whale hunt.

Russia

The Russian commercial fleet in the Norwegian Sea ecoregion and adjacent waters is composed of about 30 large vessels (62–120 m in length) targeting pelagic species including NSS herring, blue whiting, and mackerel using pelagic trawls. The pelagic fleet conducts most of its fishing activities in international waters and fewer in the Norwegian EEZ. About 50 smaller vessels (< 60 m) target demersal fish, including cod, haddock, saithe, redfish, Greenland halibut, and Atlantic wolffish, using mostly bottom trawls. Pelagic fish contribute most to the Russian fishery (about 90 % of the catches) in this ecoregion.

Iceland

The Icelandic fleet operating in the Norwegian Sea ecoregion is composed of about 19 large vessels (> 60 m length). They all target pelagic fish (NSS herring, mackerel, and blue whiting) with pelagic trawls. Two of the vessels freeze the catches on board while the others bring the catches ashore in refrigerated sea water (RSW) tanks.

United Kingdom

The UK fishery operating in the Norwegian Sea ecoregion fishes mainly in ICES Division 2.a using bottom and midwater trawls with the occasional gillnetting and purse-seining. A small number of vessels operate in this area and catch a variety of demersal and pelagic species. In 2020, three bottom otter trawlers (40–90 m length) targeted cod, together with small amounts of saithe, haddock, redfish, and other species. The four midwater trawlers (75–120 m) fishing in 2020 targeted NSS herring, mackerel, and blue whiting.

Faroe Islands

The Faroese fleet in the ecoregion consists of 12 large (> 55 m length) vessels targeting pelagic species (NSS herring, mackerel, and blue whiting) with pelagic trawl (mainly) or purse seine. One of the vessels freeze the catch on board while the rest use RSW tanks to bring the catch ashore. In addition, a handful of smaller trawlers (35–50 m length without RSW tanks) deliver the catch (mackerel) to the larger vessels at sea; the number of vessels in this last category has decreased much over the last 5–8 years. In the description of fisheries, some Faroese fisheries are mentioned in Subarea 2, but these all take place outside the Norwegian Sea ecoregion.

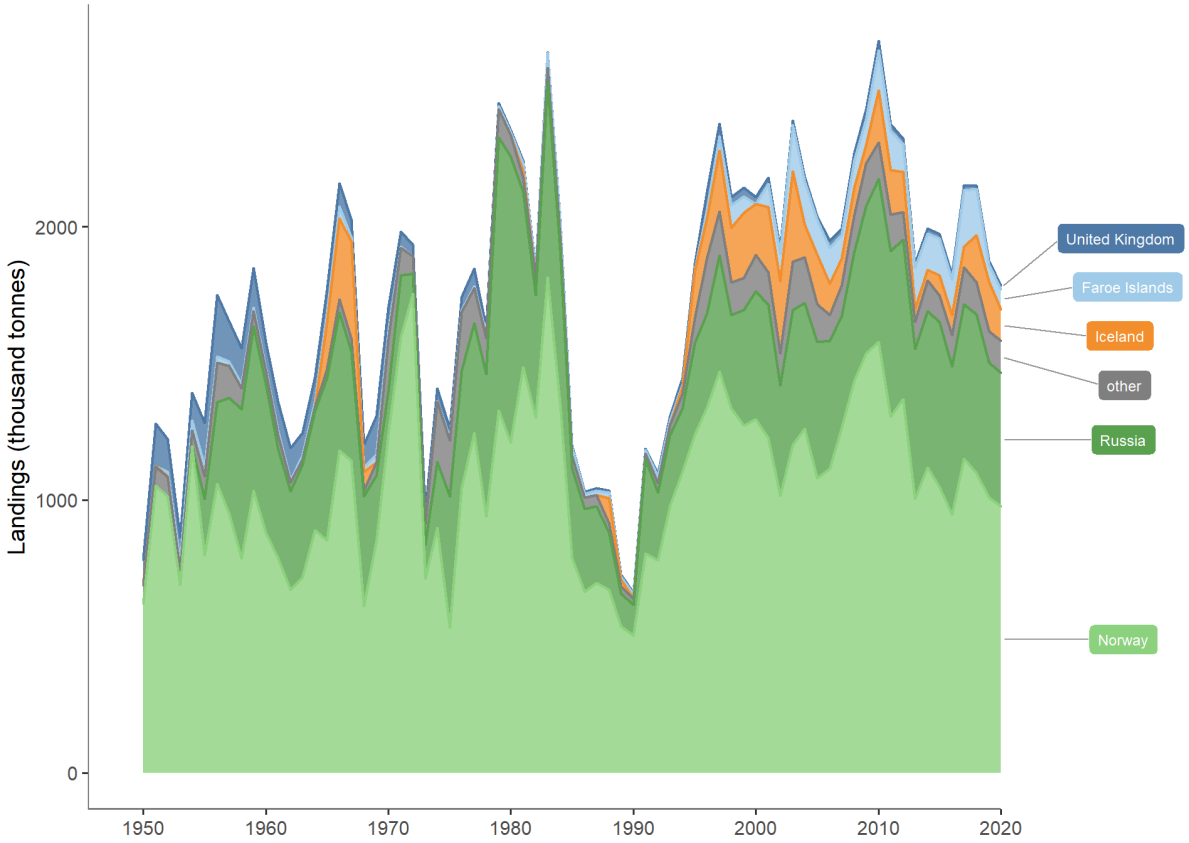


Figure 2 Landings (thousand tonnes) from ICES Subarea 2. This approximates to the majority in the Norwegian Sea ecoregion 1950–2020, by (current) country. The five countries with the highest landings are shown individually; the remaining countries are aggregated and displayed as "other". Only a minor part of the cod and haddock catches included in this figure are taken in the Norwegian Sea ecoregion.

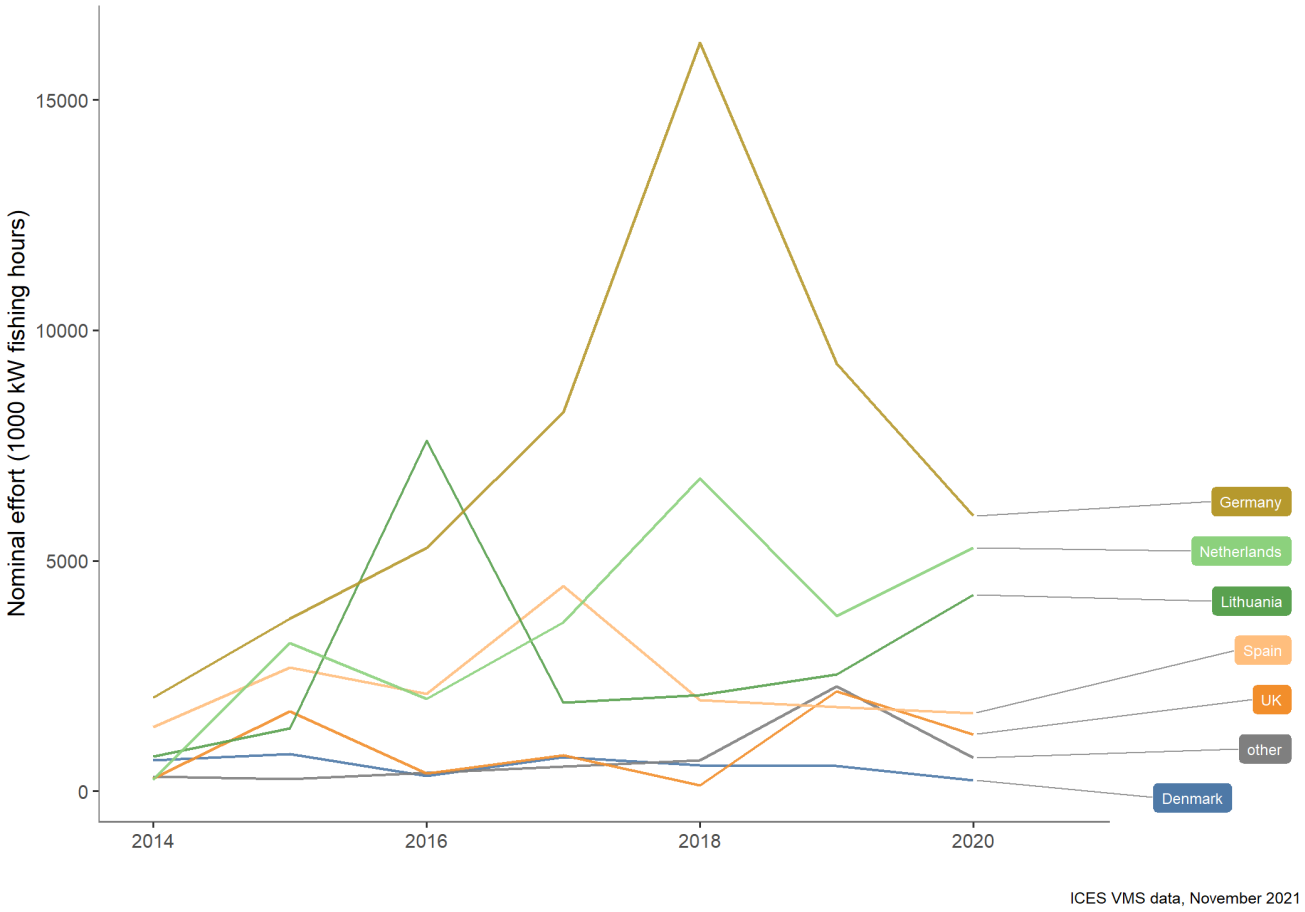


Figure 3 ICES Subarea 2. Fishing effort (1000 kW days-at-sea) 2014–2020 for the main countries fishing in the ecoregion and submitting VMS data.

Catches over time

Landings and discards are considered separately below. Data on landings have been collected for many years, whereas information on discards have only been collected consistently during the most recent years.

Landings

Fisheries in the ecoregion catch a large diversity of species. These have been categorized into species that are pelagic, demersal, crustacean, elasmobranchs, and benthic (e.g. flatfish).

The activities in the ecoregion are dominated by pelagic and demersal fisheries. Landings of pelagic species within the ecoregion in recent decades show large fluctuations, with peaks in the mid-1960s, early 1980s, and early 2000s (Figure 4), mainly brought on by fluctuations in the landings of herring, blue whiting, mackerel, and capelin (Figure 5). These fluctuations in landings correspond to the large fluctuation in stock size of herring and capelin (cap.27.2a514) over the last decades. Note that the majority of this capelin stock catches are taken outside the ecoregion.

Historically the demersal fisheries have also fluctuated, although less pronounced than the pelagic fishery. Peaks in landings occurred in the mid-1950s, early 1970s, mid-1990s, and since 2011 landings have been at their highest level, with landings dominated by cod, haddock, and saithe. Most of the variation in the total landings pattern in recent years can be attributed to fluctuations in mainly cod and to a lesser extent haddock landings. Saithe landings have been fairly stable in recent years, with a slight increasing trend since 2017 (Figure 4).

Since the 1970s, catches of harp seals have generally been lower than the TAC. Hooded seals were protected in 2007 due to low population level. Norwegian landings of minke whales peaked in the late 1950s, when around 4000 animals were taken per year. After this, landings decreased to 1500–2000 animals in the 1970s and early 1980s, until the moratorium on whaling temporary halted the hunt between 1987 and 1993. Thereafter, landings have been much lower, averaging around 500 animals per year.

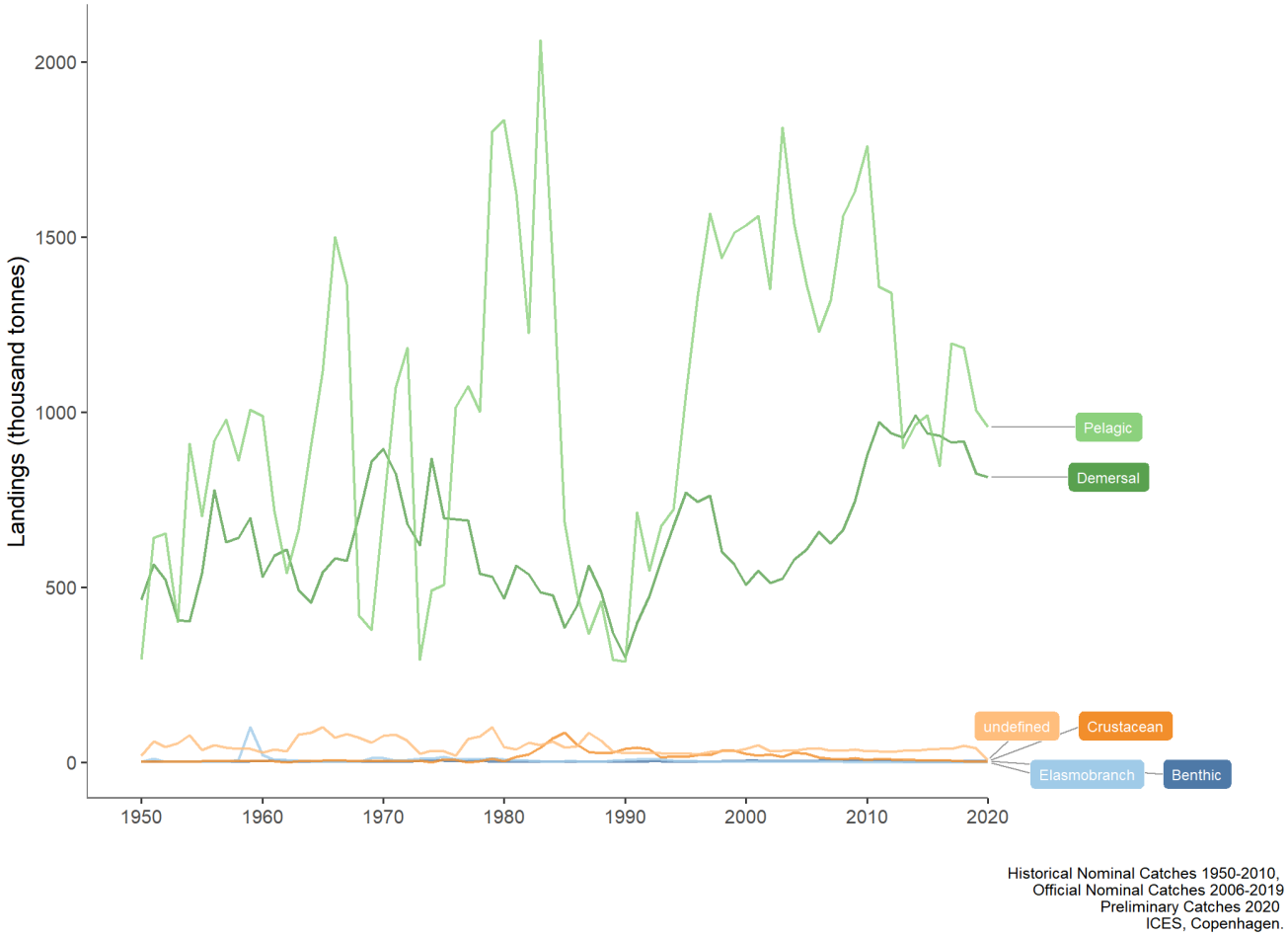


Figure 4 Landings (thousand tonnes) from ICES Subarea 2 1950–2020, by fish category. Table A1 in the Annex details the species that belong to each fish category. The demersal fish catches in this figure are dominated by cod and haddock. Only a minor part of those catches is taken in the Norwegian Sea ecoregion. Catches of capelin (cap.27.2a514) , one of four major pelagic species, are mostly taken outside the ecoregion.

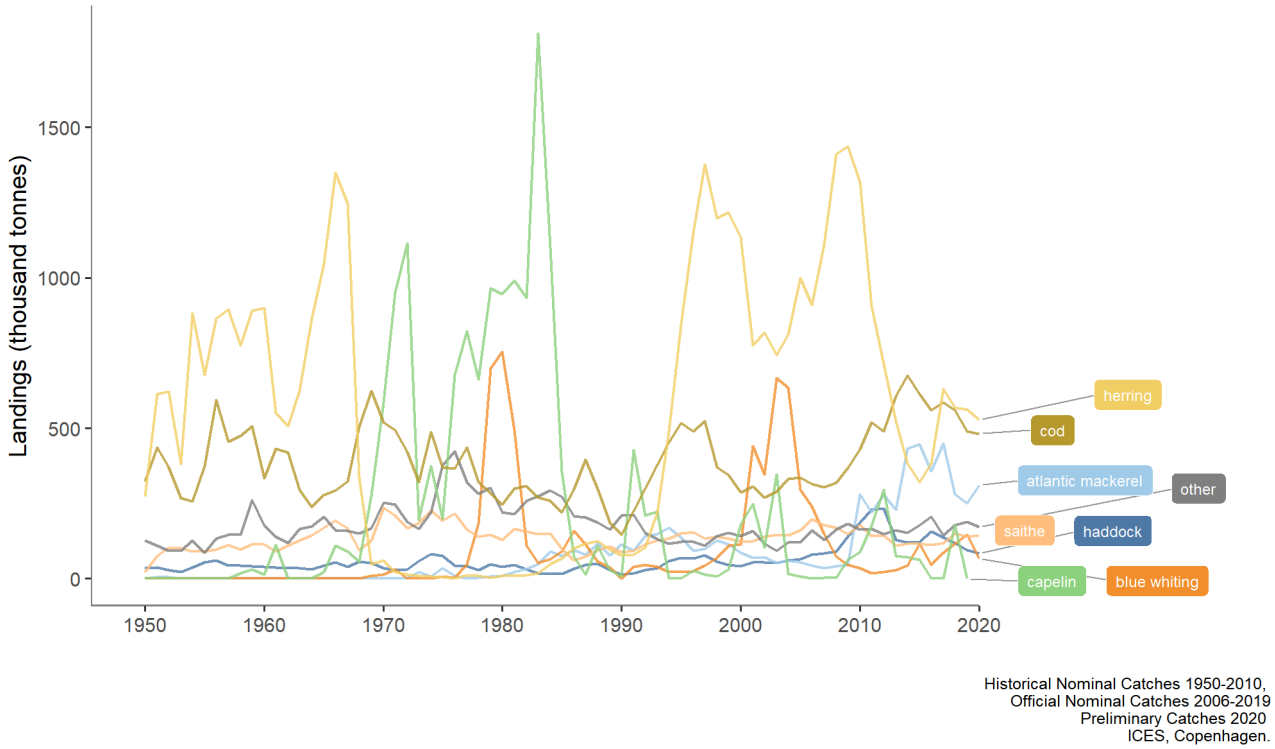


Figure 5 Landings (thousand tonnes) from ICES Subarea 2 1950–2020, by species. The six species with the highest cumulative landings over the entire time-series are displayed separately; the remaining species are aggregated and labelled as "other". Only a minor part of the cod, haddock, and capelin catches included in this figure are taken in the Norwegian Sea ecoregion.

Discards

Information about discards is sparse. The discard rate for elasmobranchs is high. This is partly due to a high bycatch of spurdog (dgs.27.nea) and skate species, mainly in Norwegian fisheries. Large skates are often landed, whereas smaller species and individuals are almost always discarded; for spurdog decisions about landing vs. discard are not quite as clear.

Description of the fisheries

A multinational fishery currently operates in the ecoregion using different fishing gears, including static gear, pelagic trawls and seines, bottom otter trawl, and bottom seines. The most commonly used equipment is bottom otter trawl, followed by static gear and pelagic trawl and seines (Figures 6 and 7). The annual catch in the ecoregion (Figure 2) from the stocks of Norwegian spring-spawning (NSS) herring, mackerel, blue whiting, Northeast Arctic (NEA) cod, haddock and saithe, ling, tusk, redfish, and greater silver smelt (aru.27.123a4) varies between 700 000 tonnes to over 2 million tonnes (2012).

Several pelagic species such as Atlantic herring, Atlantic mackerel, and blue whiting have wide-ranging migrations and move into the ecoregion to feed on plankton during spring to autumn. During this period of the year, purse seine and pelagic trawl are the main gears in the fishery for the major pelagic species throughout the southern part of the ecoregion. Additionally, in some years, there is a fishery for herring in the north-eastern part of the ecoregion during the fourth quarter. The herring fishery operates (a) in the first quarter of the year during fish migration to the spawning grounds along the Norwegian coast, (b) in the third quarter while the fish are feeding in the central part of the Norwegian Sea, and (c) in the fourth quarter during the return migration to the wintering areas. In later years, return to the overwintering areas has been delayed and most of the fishery has been in the fourth quarter of the year. Most of the mackerel fishery takes place in the third quarter while the mackerel are feeding in the Norwegian Sea. The fishery for blue whiting is mostly concentrated on the spawning grounds outside the ecoregion (west of Ireland and Scotland), but a minor part of the fishery on blue whiting takes place during the second half of the year with pelagic trawl.

Along the eastern part of the ecoregion, otter trawl, set nets and seine (Danish and purse-seine) are the major gears in the fishery for demersal species (cod, haddock, and saithe), particularly on coastal banks and the deeper part of the shelf along the Norwegian coast. Ling and tusk are caught predominantly with longline. The highest concentrations of fisheries using static gears such as gillnets are found in areas closer inshore in coastal and fjordic waters.

Fisheries for Greenland halibut and beaked redfish occur along the continental slope. Fisheries for ling and tusk occur on coastal banks along the Norwegian coast. Golden redfish and blue ling (bli.27.nea) are taken as bycatch in other fisheries.

Wrasses (mainly *Labrus bergylta*) for use as cleaner fish for delousing in the salmon farming industry are caught in a coastal trap fishery.

The Norwegian hunt of harp seals is directed toward weaned pups (beaters) or older animals on their moulting grounds in the ice-filled areas east of Greenland (the West Ice). When hooded seals were hunted, it was a pure pup hunt. The Norwegian minke whale hunt targets whales while they are at feeding grounds at high latitudes, including the areas around Jan Mayen.

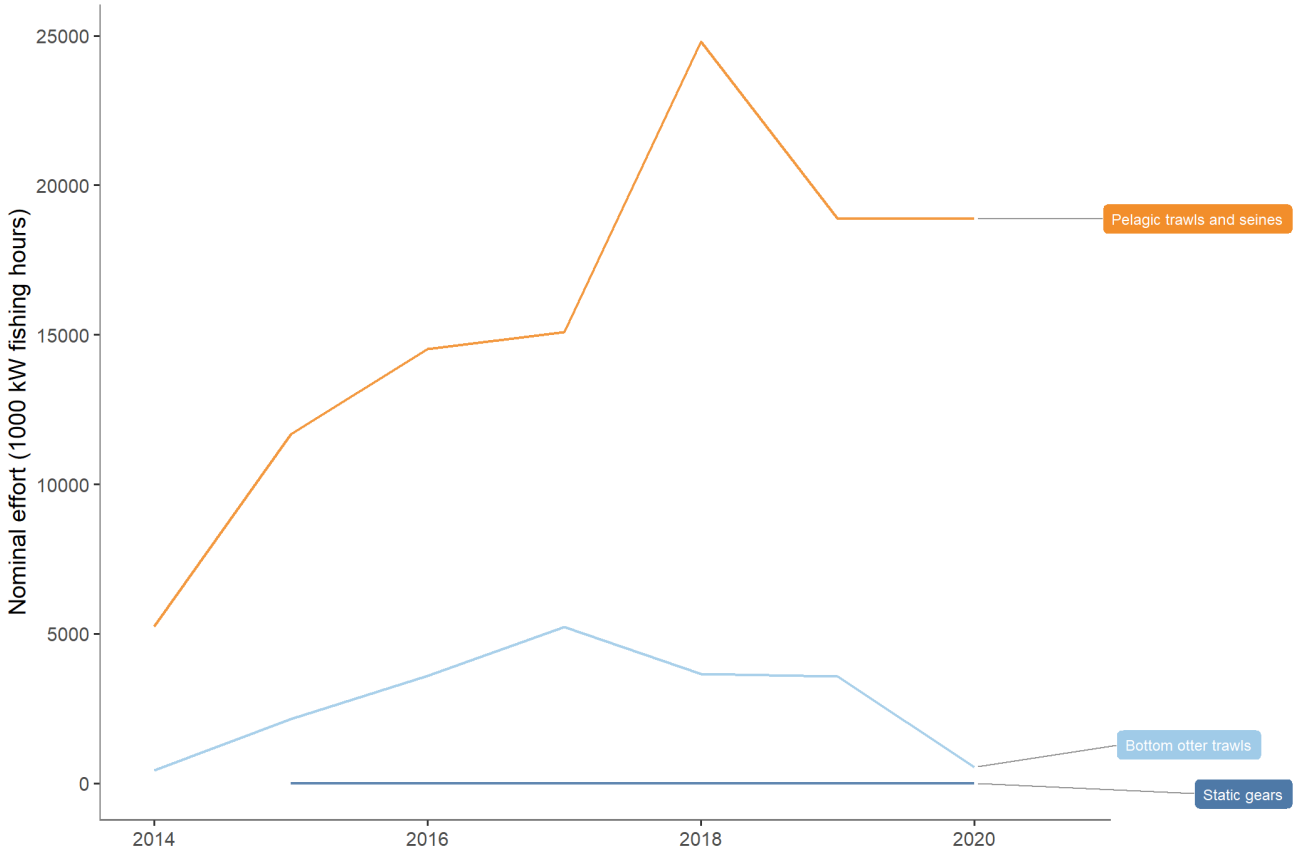


Figure 6 ICES Subarea 2. Fishing effort (thousand kW hours-at-sea) 2014–2020 by gear type for vessels over 15 m submitting VMS data. Only a minor part of the effort with bottom otter trawl shown in the figure is applied in the Norwegian Sea ecoregion.

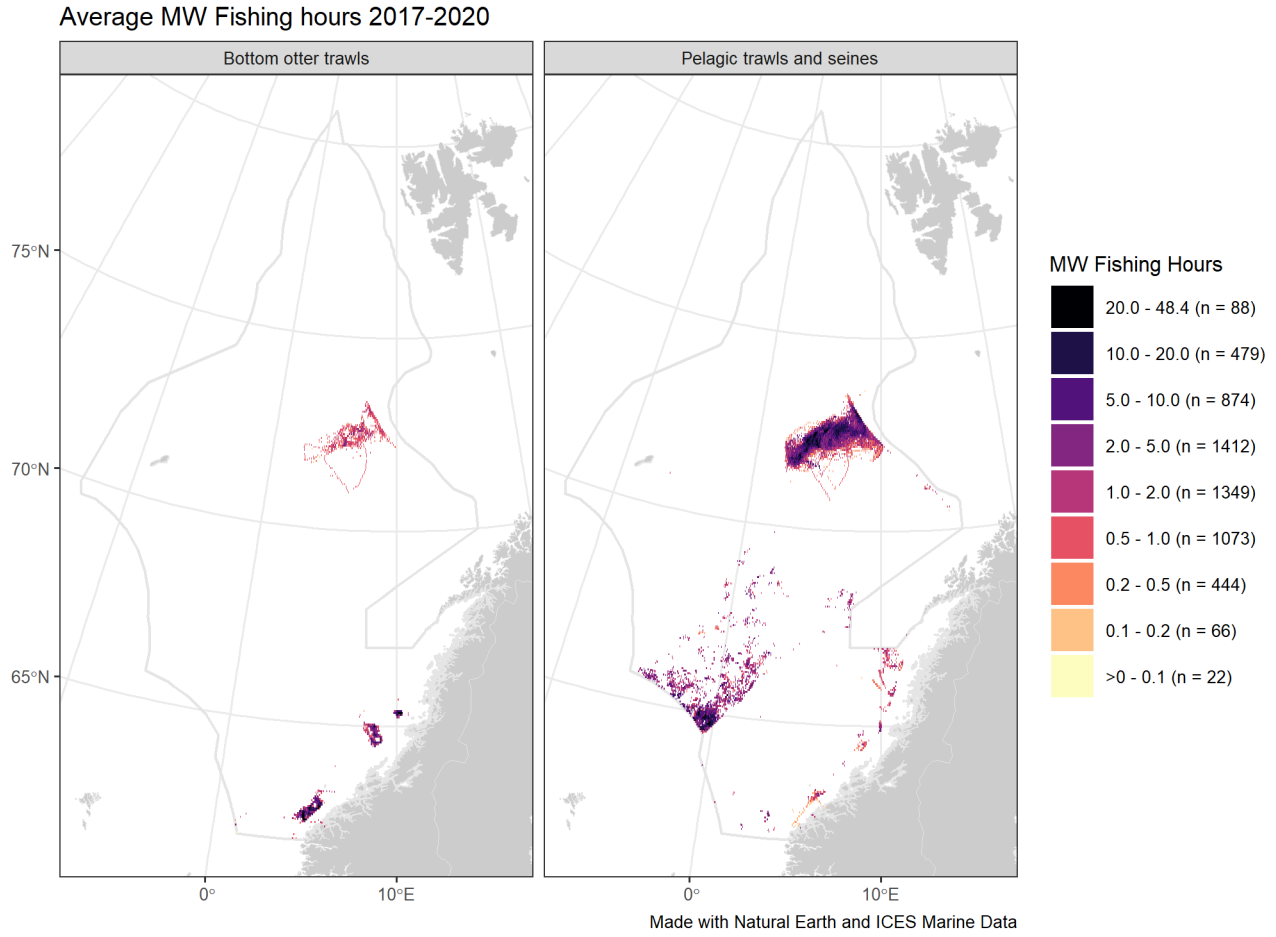


Figure 7 Spatial distribution of average annual fishing effort (MW fishing hours) in the Norwegian Sea ecoregion, by gear type. Fishing effort data are only shown for vessels > 12 m with vessel monitoring systems (VMS); this will bias the distributions, particularly in coastal areas.

Ling

In 2020, 99% of the catches of ling in Subarea 2 were taken by Norway. Other countries participating in the fishery were Russia, Faroe Islands, France, and Germany. The fishery for ling is demersal and 37% of the catches are taken in the longline fishery, 59% in the gillnet fishery, and 4% by other gears (mainly trawl). There is no quota for the Norwegian ling fishery, but vessels participating in the fishery in Subarea 2 are required to have a license. No minimum length applies in the Norwegian EEZ.

Tusk

In 2020, 98% of all tusk caught in Subarea 2 were landed by Norway. Other countries participating in the fishery were Russia, Faroe Islands, France, and Germany. The fishery for tusk is demersal and 92% of the catches are taken in the longline fishery, 7% in the gillnet fishery, and 1% by other gears (mainly trawl). There is no quota for the Norwegian tusk fishery, but vessels participating in the fishery in Subarea 2 are required to have a license. No minimum length applies in the Norwegian EEZ.

Blue ling

In 2020, 99% of all blue ling caught in Subarea 2 were landed by Norway. Other countries participating in the fishery were France and the United Kingdom. The fishery for blue ling is demersal and 87% of the catches are taken in the gillnet fishery, 3% in the trawl fishery, and 10% in the longline fishery. Direct fishing for blue ling in the Norwegian Sea is prohibited. A 10% admixture of blue ling as bycatch is allowed by Norwegian regulations.

Greenland halibut

Most of the catches of Greenland halibut in the ecoregion are taken along the eastern continental slope of the Norwegian Sea outside the coast of Norway and north towards Svalbard. A lesser part is caught within the Barents Sea, and a minor proportion is caught around Jan Mayen. The Joint Norwegian–Russian Fisheries Commission has decided on a distribution key for Greenland halibut, giving Norway a share of 51%, Russia 45%, and 4% to other countries. The catches during last years are mainly taken by trawls (about 60%), longline (26%), gillnets (11%), and other gears (3%). The fisheries are regulated by TAC and a minimum legal size.

Beaked redfish

Beaked redfish have been targeted by a pelagic fishery outside the Norwegian Exclusive Economic Zone (EEZ) since 2004. Direct fishing has been permitted within the Norwegian EEZ since 2014, with bottom trawls as well as with pelagic trawl. There is no directed fishery for beaked redfish with other gears. Of the reported catch of 54 227 tonnes in Subarea 2 in 2020, 62% were taken by Norway, and 25% by Russia. The Norwegian and Russian catches are mainly from the Norwegian EEZ or taken as bycatch in the Svalbard zone. EU countries, the Faroe Islands, Russia, and UK also fished in the international waters. Of the Norwegian catches 94% were taken by bottom trawl. Since the different species of redfish are difficult to distinguish from one another, especially when they are young, all bycatch regulations apply to both beaked and golden redfish. As per Norwegian regulations, the minimum length is 30 cm outside and 32 cm within 12 nautical miles (NM) from the coast, with a bycatch of 10% per haul allowed. Allowed bycatch in fishing for other fish is 20% for trawls outside 12 NM, and 10% for trawls within 12 NM, in both cases per haul and upon landing. For other gears, a 10% bycatch in weight per week applies inside 12 NM. Vessels using conventional gear and of less than 21 m in length are allowed 30% bycatch in weight per week from 1 August to 31 December. Bycatch of juvenile redfish is limited to three individuals per 10 kg of shrimp.

Golden redfish

Golden redfish is on the Norwegian red list and direct fishing is prohibited, except fishing with handline from boats under 15 m in length; these fisheries account for 1% of the total catch in the Norwegian EEZ of Subarea 2. Bycatch regulations are the same as for beaked redfish because of the morphological similarity of the two species, especially when they are small. Despite a zero-catch advice for 2017–2022, catches in 2020 were 6940 tonnes in Subarea 2, 68% of which were reported by Norway. The largest proportion of catches are with bottom trawls (57%) followed by gillnet set yarns (25%).

Greater silver smelt

Greater silver smelt is a benthopelagic species caught in a semi-pelagic fishery using trawl. Over 99% of the catches in subareas 1 and 2 are caught in a targeted fishery by Norwegian midwater and bottom trawlers. Landings have decreased since 2018.

Elasmobranchs

While no fisheries target elasmobranchs in this ecoregion, they are caught in various demersal fisheries. The total landings for Subarea 2 have been between 230 and 620 tonnes per year since 2010, with the highest landings reported for 2020. On average, 41 % of these landings are spurdog and 52 % skates. All skate species in the ecoregion may be taken as bycatch, with only larger individuals thought to be landed. The main species landed tend to be larger specimens of long-nosed skate, spiny-tail skate, and thornback ray. Discards of skates vary between species, but are assumed to be almost 100% for fish below 50 cm. For round ray and starry ray, nearly all fish are probably discarded, whereas discarding of thornback ray by the coastal fleet is expected to be negligible. Rabbit fish and velvet-belly lantern shark are also mostly discarded.

Haddock

Haddock catches from Subarea 2 peaked between 2009 and 2012, corresponding with a peak in spawning-stock abundance, but have since 2016 decreased to the 2008 levels.

Russia and Norway catch 57% and 42% respectively of the total haddock landings from Subarea 2. Considering the entire subarea, about 44% of the Norwegian landings were caught in coastal and shelf areas, 35% on the slope off northern Norway, and only 2% in more southern and western areas. The remainder was taken in areas around Svalbard, mainly with bottom trawls (66% of all landings in area 2.b.2). About half of the total landings are from bottom trawls, followed by 23% from longline activities, and 16% from Danish seine.

Saithe

Norwegian catches within Subarea 2 accounted for 86% of total Norwegian saithe landings from subareas 1 and 2, of which close to 38% were taken in areas overlapping the ecoregion. Almost all the saithe catch is taken on the Norwegian shelf. The main fishing gears deployed in the shelf area are bottom trawls (32% of catches), set nets (36%), purse-seine (26%), and bottom seine (5%). Further offshore and in the northern parts of area 2 bottom trawls take more than 95% of the catch.

Cod

Cod landings from Subarea 2 increased from 2007, peaked in 2014, and have since decreased steadily. Norwegian and Russian catches accounted for 50% and 39% of total cod landings from Subarea 2 in 2019, respectively. Of the Norwegian landings approximately 21% were taken in the ecoregion. Typically, high catches are recorded in this area in February and March when spawning cod move in from the Barents Sea. The fishing gears that contributed to the Norwegian landings from the ecoregion were set nets (53% of catches), Danish seine (27%), longline (9%), and bottom trawls (3%).

Herring

The fishery on Norwegian spring-spawning herring in the ecoregion has fluctuated greatly. The stock collapsed at the end of the 1960s but has since recovered and the fishery is now managed by a management strategy agreed upon by the Coastal States (Norway, Russia, Iceland, the Faroe Islands, UK, and EU). Currently, there is not an agreement among all the parties on the sharing of the total allowable catch, and the total catch has exceeded the catch advice for many years. Most of the landings in 2020 were taken by Norway, followed by Iceland, Faroe Islands, Russia, and Denmark. Several other countries catch smaller amounts of herring. The landings are taken by purse seine and pelagic trawl. In 2019, 36% of the total catch was caught inside the North-East Atlantic Fisheries Commission (NEAFC) Regulatory Area, whereas in 2020 this proportion decreased to 13%.

Mackerel

Landings of mackerel have fluctuated less than the herring landings and have been on a high level in recent years. At present no long-term management strategy for mackerel is agreed by all parties involved in the mackerel fishery, and the catch advice is based on the MSY approach. However, there is not an agreement among the parties on the sharing of the total allowable catch, and consequently the catches have been above ICES catch advice for many years. The major landings of mackerel in 2020 from the ecoregion were taken by Iceland, Russia, Greenland, Faroe Islands, UK, and Norway. Landings are mostly taken with pelagic trawl but a minor part with purse seine. In 2020, 24% of the total catch was taken inside the NEAFC Regulatory rea.

Blue whiting

A long-term management strategy on blue whiting was agreed by the European Union, the Faroe Islands, Iceland, and Norway in 2016. Currently, there is not an agreement among all the parties on the sharing of the total allowable catch, and the catch has exceeded the catch advice for many years. Landings of blue whiting are mostly from outside the ecoregion, but some fishery takes place within the region during the second half of the year – mainly as bycatch in the herring and mackerel fisheries. The blue whiting fishery has fluctuated, with total landings above 2 million tonnes in the early 2000s, declining to a minimum of 100 000 tonnes in 2012. Since then landings have been increasing. The major fishing nations in the ecoregion are Norway, Faroe Islands, Iceland, Russia, and Germany. Landings are mainly taken with pelagic trawl (99%).

Capelin

In the ecoregion, there have been no landings of capelin in recent years, but during the 1980s and 1990s landings were high (above 500 000 tonnes) and consisted of summer fishery in the Jan Mayen area. Major fishing nations were Iceland, Norway, and Faroe Islands.

Seal and whale hunting

In the Norwegian seal hunt, seals are shot on ice with rifles from vessels. Minke whales are hunted using 50 mm or 60 mm harpoon cannons.

Recreational fisheries

In the Norwegian Sea, marine recreational fisheries can be divided into the marine angling tourism sector, and local marine recreational fisheries. While non-resident marine angling tourists can only use handheld hook-and-line fishing tackle, resident marine recreational fishers can use a range of fishing gears, including gillnets, longlines, pots, jigging machines, and handheld hook-and-line fishing tackle. In addition, resident marine recreational fishers can sell a limited amount of their catch. Except for the lobster fishery, no fishing license is required. Popular target species for tourists are cod and saithe (Vølstad *et al.*, 2011), and catch-and-release rates are high (Ferter *et al.*, 2013).

Fisheries management

The Norwegian Sea ecoregion includes parts of the EEZs of Norway, part of the Fisheries Protection Zone around Svalbard, and the North East Atlantic Fisheries Commission (NEAFC) regulatory area of the Norwegian Sea. Management of the pelagic stocks in the region is conducted by Coastal States and catching opportunities for pelagic stocks in the area are agreed during Coastal States meetings. Norway manages the fishery in the Norwegian EEZ (i.e. within 200 nautical miles). The status of Svalbard waters is partly unresolved. Norway claims jurisdiction of the sea area around Svalbard based on the Svalbard Treaty from 1920 and has established a 200 nautical mile wide "fishery protection zone" around the archipelago. All nations that historically have been fishing in the Svalbard area are still fishing there, but Norway exercises control in the zone.

The Joint Norwegian–Russian Fisheries Commission manages seal hunting, based on advice from ICES. Commercial minke whaling is based on the International Whaling Committee's (IWC's) Revised Management Procedure (RMP). The RMP requires catch history and abundance estimates as input and calculates annual quotas for six-year periods. There are several regulations in place for different stocks in the ecoregion.

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, i.e. $F < F_{pa}$ and $SSB > B_{pa}$ (Figure 8). Of the 7 pelagic stocks, 5 have an F_{MSY}, and 3 are fished at or below the F_{MSY} target level while 2 are fished above the target level. Four of the five pelagic stocks with an MSY $B_{trigger}$ are above MSY $B_{trigger}$. The largest demersal stocks (cod, haddock, saithe) are all above MSY $B_{trigger}$, while cod and haddock are fished slightly above F_{pa}. The status for many of the other demersal stocks is unknown, as is the status of most elasmobranch stocks is unknown.

Approximately 27% (6 out of 22) of the total number of stocks are sustainably fished (i.e. D3C1, where $F < F_{MSY}$); these account for around 41% of the total landings (Figure 9). 6 out of 22 of the stocks were assessed to be above MSY $B_{trigger}$ (D3C2); these accounted for more than 90% of the total biomass caught.

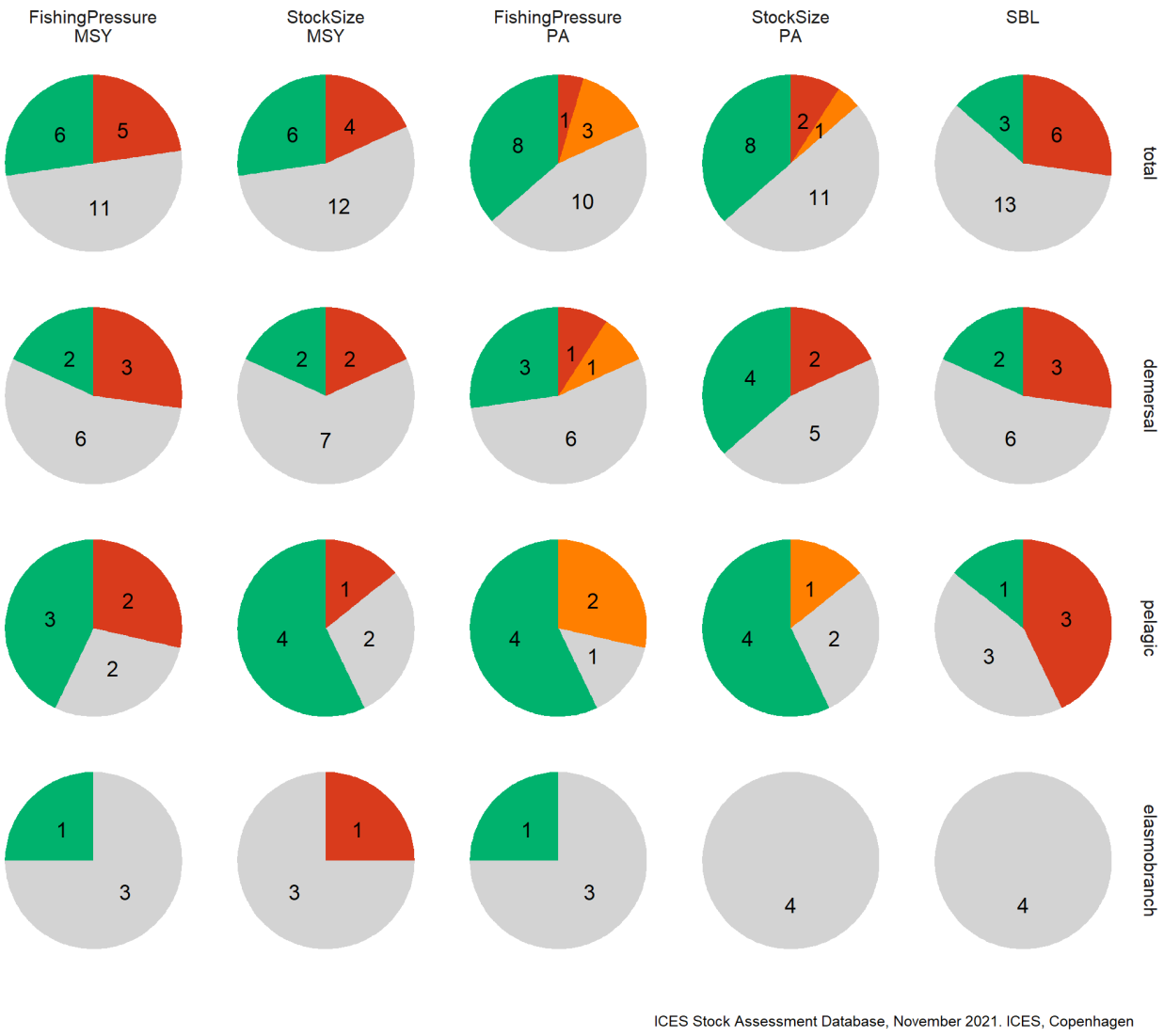


Figure 8 Status summary of Norwegian Sea stocks in 2021 relative to ICES maximum sustainable yield (MSY) approach and precautionary approach (PA). Grey represents unknown reference points. *For the MSY approach*: green represents a stock that is either fished below F_{MSY} or whose size is greater than MSY $B_{trigger}$; red represents a stock that is either fished above F_{MSY} or whose size is lower than MSY $B_{trigger}$. *For the PA*: green represents a stock that is fished at or below F_{pa} while its size is equal to or greater than B_{pa}; orange represents a stock that is either fished between F_{pa} and F_{lim} or whose size is between B_{lim} and B_{pa}; red represents a stock that is fished above F_{lim} or whose size is less than B_{lim}. Stocks with a fishing mortality at or below F_{pa} and a size above B_{pa} are defined as being inside safe biological limits (SBL). If this condition is not fulfilled, the stock is defined as being outside safe biological limits. For stock-specific information, see tables A1 and A2 in the Annex.

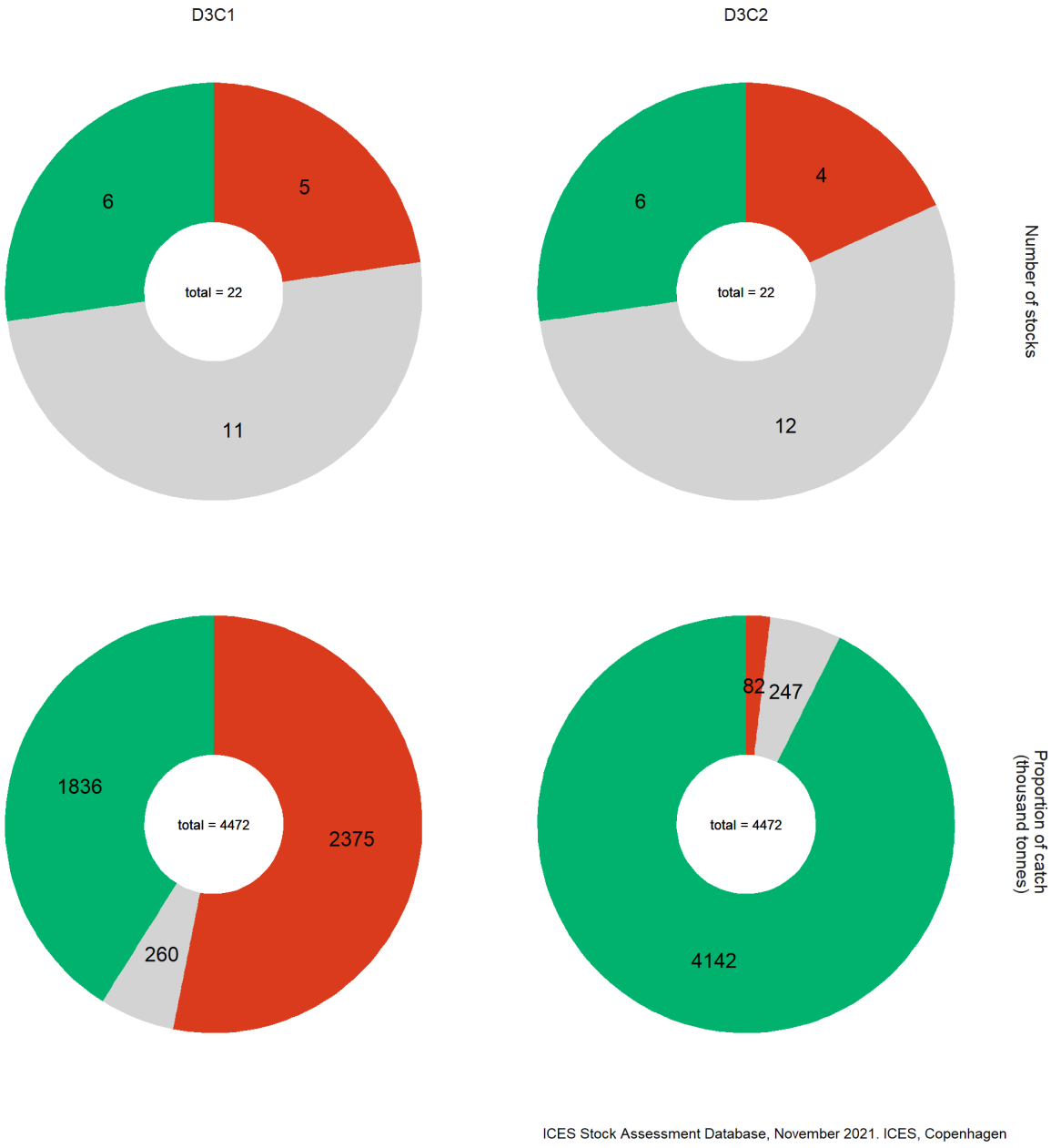


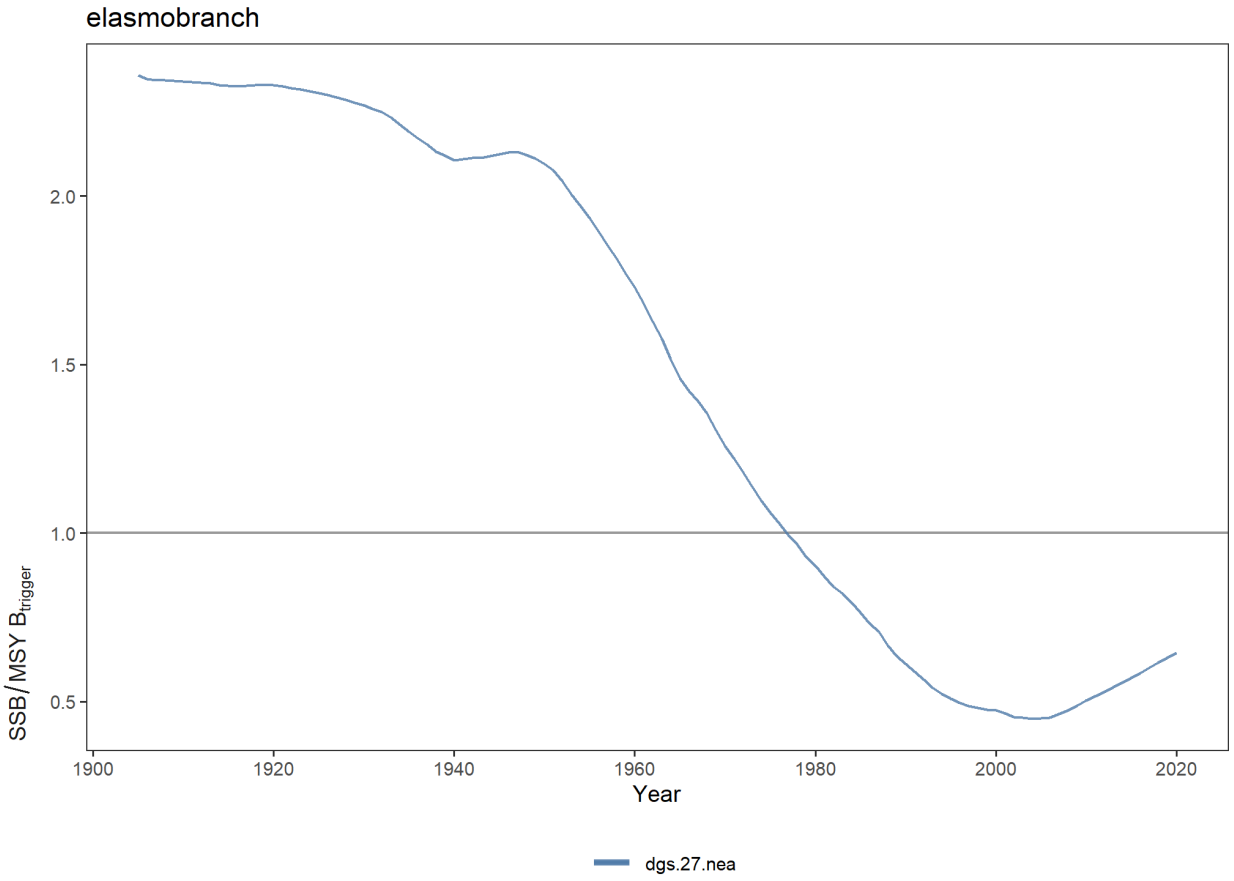
Figure 9 Status summary of Norwegian Sea stocks in 2021 relative to the EU Marine Strategy Framework Directive (MSFD) assessment criteria of the level of pressure of fishing activity (D3C1) and reproductive capacity of the stock (D3C2). Green represents the proportion of stocks that is either fished below F_{MSY} or for which the stock size is greater than MSY $B_{trigger}$, for criteria D3C1 and D3C2. Red represents the proportion of stocks that is either fished above F_{MSY} or for which 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 A1 in the Annex.

The SSB relative to biomass reference points of spurdog decreased from the 1980s until 2006 (Figure 10). The stock was depleted and in danger of collapse and the TAC was reduced significantly. After a zero TAC was introduced in 2011, the SSB ratio has increased but is still below the target level.

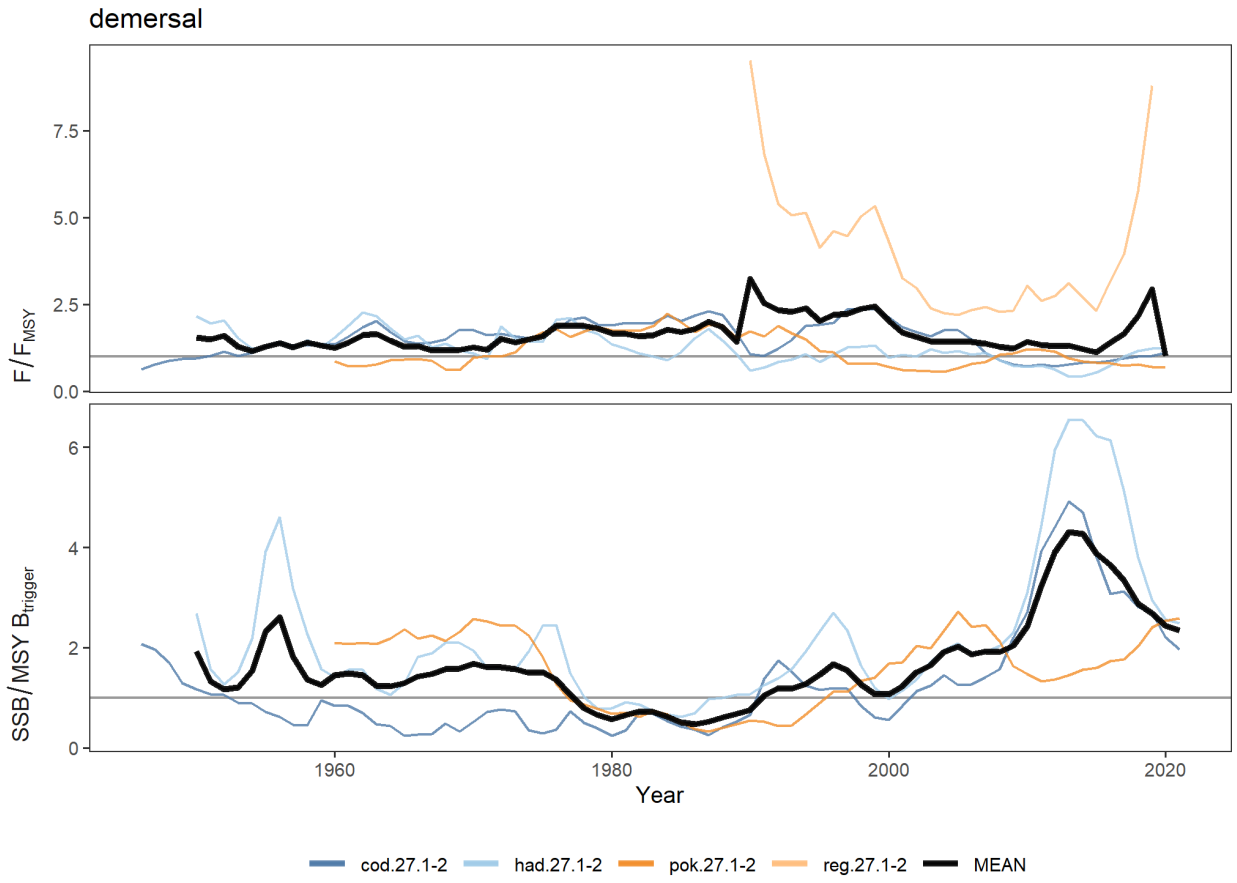
The mean fishing mortality ratio for the major demersal stocks – cod, haddock, and golden redfish– shows a declining trend since the mid-1990s until 2015, followed by a sharp increase in 2018-2019 largely driven by changes in mortality of golden redfish. (Figure 10). The fishing mortality for cod and haddock is slightly above F_{MSY}, while fishing mortality for golden redfish, which is not assessed based on F_{MSY} but F_{MGT}, is way above target level. The mean SSB ratio shows an increasing

trend over the same period until 2013/2014, and a steep decrease in the last few years. The mean values for cod, haddock and saithe, however, remain above MSY $B_{trigger}$ and below MGT $B_{trigger}$ for golden redfish.

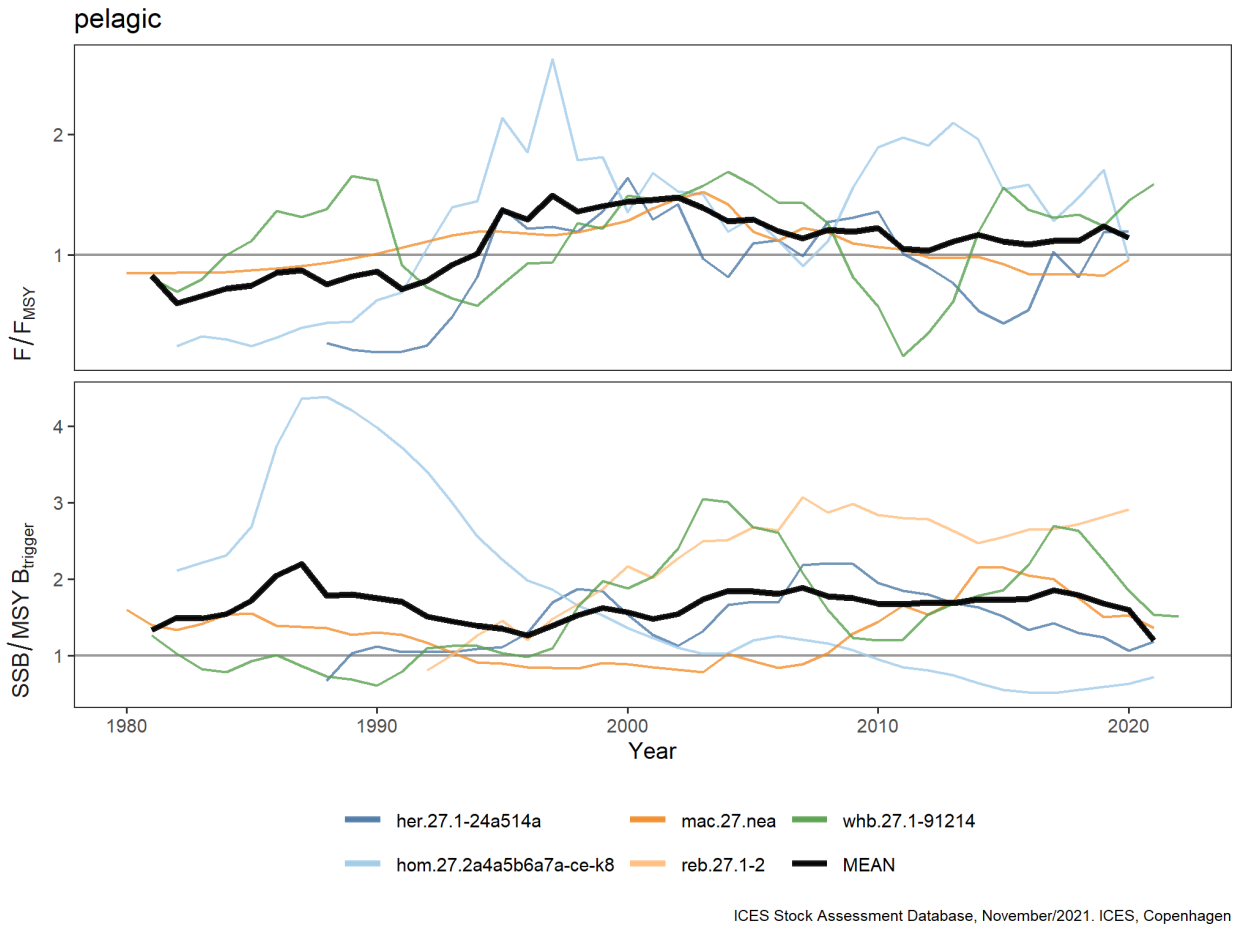
For pelagic stocks, the mean fishing mortality ratio has been stable slightly above 1 in recent years. The mean biomass ratio for pelagic species has remained stable above 1 since 2000 but with a decrease in the last few years (Figure 10).



ICES Stock Assessment Database, November/2021. ICES, Copenhagen



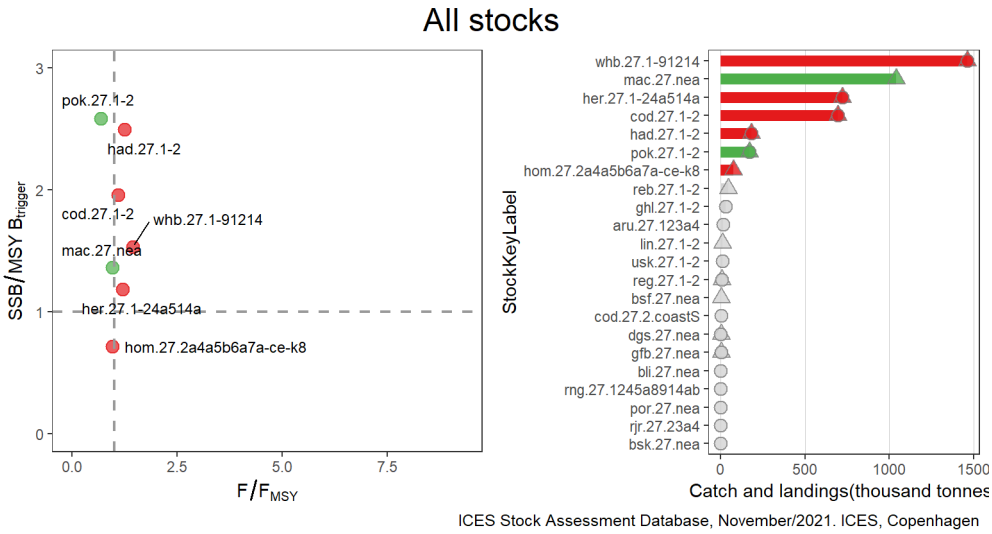
ICES Stock Assessment Database, November/2021. ICES, Copenhagen

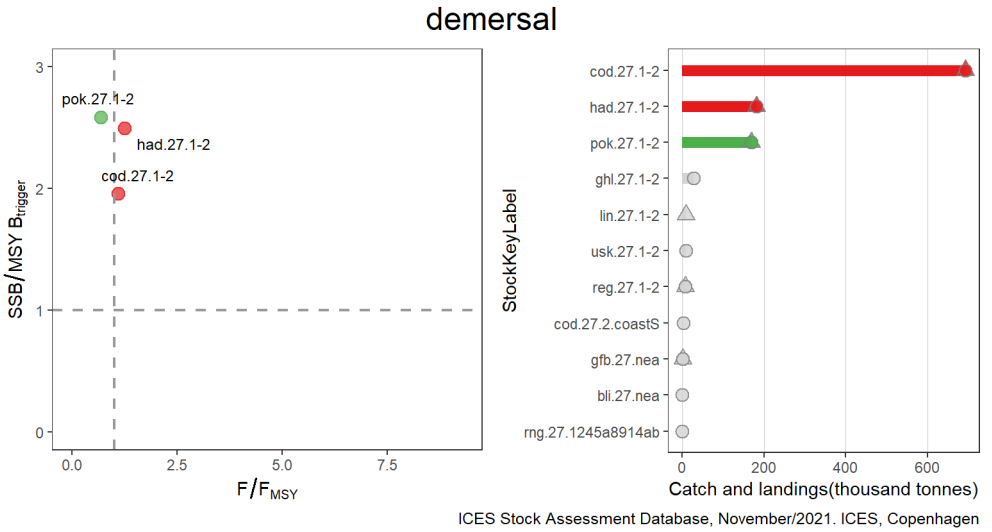


ICES Stock Assessment Database, November/2021. ICES, Copenhagen

Figure 10 Temporal trends in F/F_{MSY} and SSB/MSY $B_{trigger}$ for Norwegian Sea elasmobranch, demersal, and pelagic stocks based on the most recent assessment. Only stocks with defined MSY reference points are considered. Stocks for which proxy reference points are available only are not shown. For full stock names, see Table A1 in the Annex. Only a minor part of the cod, haddock, blue whiting, and horse mackerel catches is taken in the Norwegian Sea ecoregion.

The stock status relative to F_{MSY} and MSY $B_{trigger}$ is shown for all stocks and partitioned by stock groups in Figure 11. All stocks presented except mackerel and horse mackerel (hom.27.2a4a5b6a7a-ce-k8) are exploited above F_{MSY}. Cod, haddock and saithe have an SSB more than two times higher than MSY $B_{trigger}$, while horse mackerel is below MSY $B_{trigger}$


All stocks
SSB/MSY B$_{trigger}$
F/F$_{MSY}$
pok.27.1-2
had.27.1-2
cod.27.1-2
whb.27.1-91214
mac.27.nea
her.27.1-24a514a
hom.27.2a4a5b6a7a-ce-k8
StockKeyLabel
Catch and landings(thousand tonnes
ICES Stock Assessment Database, November/2021. ICES, Copenhagen


demersal
SSB/MSY B$_{trigger}$
F/F$_{MSY}$
pok.27.1-2
had.27.1-2
cod.27.1-2
StockKeyLabel
Catch and landings(thousand tonnes)
ICES Stock Assessment Database, November/2021. ICES, Copenhagen

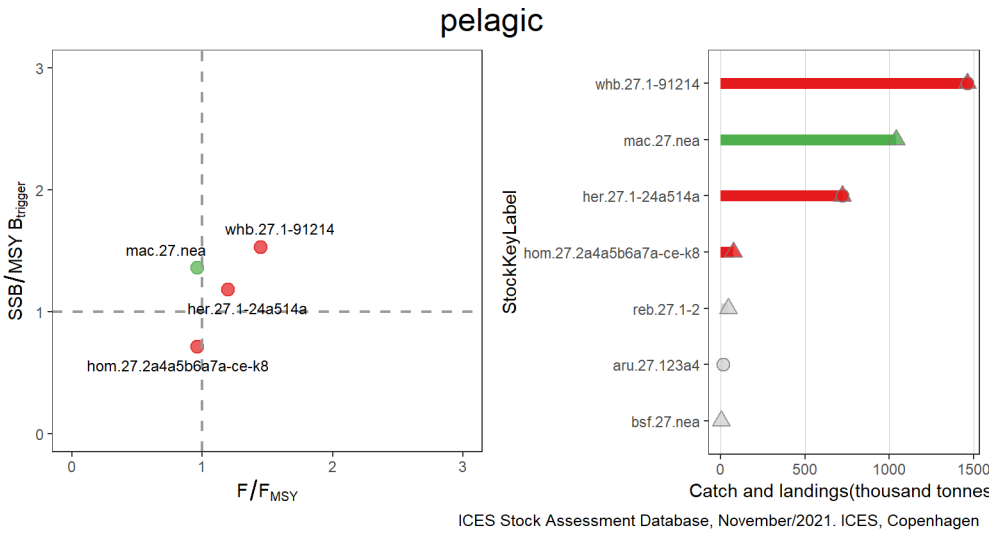


Figure 11 Status of Norwegian Sea stocks relative to the joint distribution of exploitation (F/F_{MSY}) and stock size (SSB/MSY $B_{trigger}$ [left panels, by individual stocks]) and catches (triangles)/landings (circles) from these stocks in 2021 [right panels]. The left panels only include stocks for which MSY reference points have been defined (MSY where available). Stocks for which proxy reference points are available only, are not shown on the left plots. Stocks in green are exploited at or below F_{MSY} while their size is also at or above MSY $B_{trigger}$. Stocks in red are either exploited above F_{MSY} or their 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 stocks with highest catch and landings across fisheries guilds in 2020. For full stock names, see tables A1 and A2.

Mixed fisheries and incidental bycatch

Fishing gear operations that harvest multiple types of fish simultaneously are defined as mixed fisheries, although some are more selective than others. Pelagic trawling and purse-seining tend to catch mostly one species, with only minor quantities of bycatch. Demersal trawling, bottom-seining, and longlining tend to catch a mixture of species. These technical 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). Most fisheries data are aggregated based on species, gear, mesh size range, ICES rectangle, and calendar quarter; this may create perceived interactions that do not occur, while more subtle interactions are missed.

Tusk, ling, blue ling, redfish, and eel

Currently the major ling fisheries are the Norwegian longline and gillnet fisheries, but bycatches of ling are taken by other gears, such as trawls and handlines. Other nations catch ling as bycatch in their trawl fisheries.

Tusk is primarily bycatch in the ling and cod fisheries. Currently the major fisheries in Subarea 2 are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears such as trawls and handlines. Other nations catch tusk as bycatch in their trawl and longline fisheries.

Blue ling is primarily caught as bycatch in the ling, tusk, and saithe longline and gillnet fisheries.

A directed demersal and pelagic fishery on beaked redfish has been permitted in the Norwegian EEZ since 2014. Reasonable catch rates and low bycatches of other species were reported for this fishery. The golden redfish is only caught as bycatch, predominantly in the gillnet fishery for saithe and bottom trawl fishery for beaked redfish. Most of the catches taken by countries other than Norway are taken in mixed fisheries together with saithe and cod.

It is estimated that around 80 000 eels are caught as bycatch in the coastal trap fisheries for wrasse, mainly *Labrus bergylta*, but the majority of these are released unharmed. Also, the estimate is uncertain because the same eels can be caught repeatedly. Eels migrate through the Norwegian Sea, but there is currently no significant marine fishery targeting eel.

Elasmobranchs

There are no fisheries targeting skates or sharks in the Norwegian Sea, though they are caught as bycatch in various demersal fisheries targeting teleost species. Bycatches in Subarea 2 are dominated by starry ray and thornback ray (although misidentification problems may exist), with composition differences between trawl, longline, and gillnet catches.

Species interaction

The Norwegian Sea is the feeding ground for some of the largest fish stocks in the world, including Norwegian spring-spawning (NSS) herring, blue whiting, and the Northeast Atlantic (NEA) mackerel. These planktivorous stocks are often referred to as the "pelagic complex" due to their substantial spatial and dietary overlap. Due to their high abundances, they can potentially have a strong ecological impact on the ecosystem and each other. The degree of competition between the species depends both on the dietary overlap and the spatial and temporal distribution of feeding activities.

Herring, one of the largest commercially exploited stocks in the ecosystem, is also a key prey species for several predators (including sea mammals, bony fishes, and sharks). Numerous studies on killer whales shows that they follow the herring. When the herring stock is large, killer whales feed almost exclusively on herring. In other areas, they take different prey and they are capable of catching seals and even young baleen whales. A change in herring abundance may force the killer whales to a dietary shift towards other fish species and marine mammals. Herring, along with blue whiting, are also important prey items for Greenland halibut, porbeagle, and for gadoids like saithe, ling, and tusk. A high mortality rate on herring and blue whiting may affect the abundance of these species that have an important ecological role along the shelf edge. Other interactions also exist but are not adequately described.

The Greenland halibut and redfishes are a part of the diet of many marine mammals, including sperm whale, bottlenose whale, harp seals, and hooded seals. Juvenile redfish are also important prey items for cod and Atlantic halibut.

Many populations of seabirds in the ecoregion have decreased steeply over the last decade and many have decreased almost constantly since monitoring began three to five decades ago. Over the last decade (2010–2020), most of the offshore feeding populations that are monitored have decreased with an average annual rate of 8.7% and more coastal species of 5.9%. No single factor explains all these trends; however, long-term breeding failures for species feeding in pelagic waters such as Atlantic puffin, black-legged kittiwake, common guillemot, and northern fulmar indicate that much of the problem along the mainland coast is related to drastic changes in the availability of forage fish (especially 0-group herring), and also linked to variations in ocean climate.

Effects of fisheries on the ecosystem

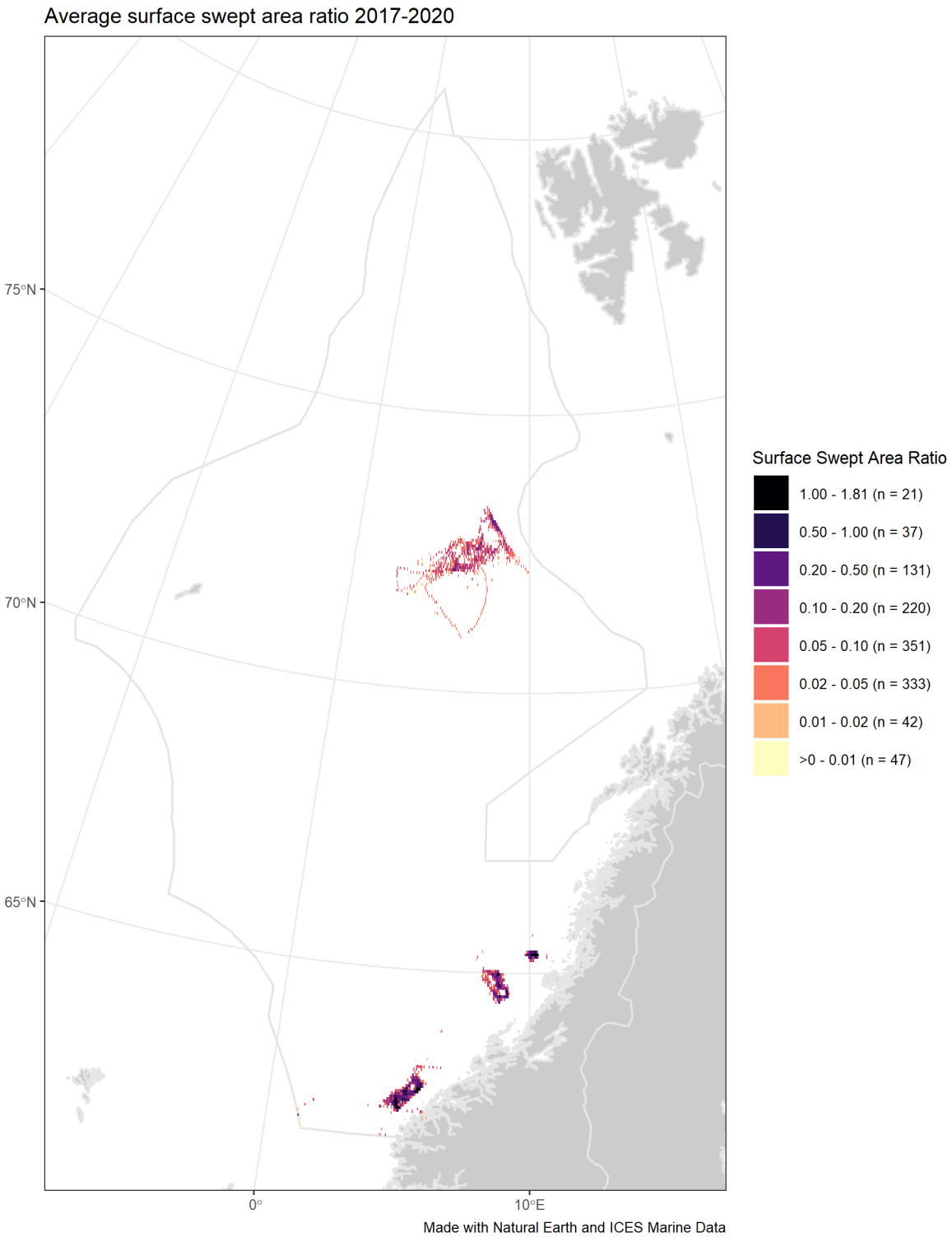
Physical disturbance

Abrasion occurs from towed bottom-contacting gear with some damage to benthic organisms and habitats. The extent, magnitude, and impact of mobile bottom-contacting fishing gear on the seabed and benthic habitats varies geographically across the Norwegian Sea. This gear type is used mainly on the shelf in the southern part of the ecoregion (Figure 12). Bottom trawling along the Norwegian continental slope is regulated through closed areas to avoid extended damage to fragile and vulnerable benthic communities and reef-building organisms (vulnerable marine ecosystems, VMEs). The greatest threat to the VMEs is from bottom fishing activity. It has been estimated that about 50% of the area of VME in the Norwegian Sea and adjacent waters overlaps with known areas of bottom fishing activity, of which about 10% is estimated to be subject to relatively high fishing pressure (Buhl-Mortensen, *et al*., 2019).

Ghost-fishing

Abandoned, lost, or discarded fishing gear is a significant problem in all fisheries. These gears continue to catch or trap fish, birds, and mammals for a long time, also known as ghost-fishing. Ghost-fishing is more problematic in deeper waters

(e.g. Greenland halibut fishery) because of lower rates of biofouling and tidal scouring so gears continue to fish effectively. The magnitude of ghost-fishing in the Norwegian Sea is not quantified.



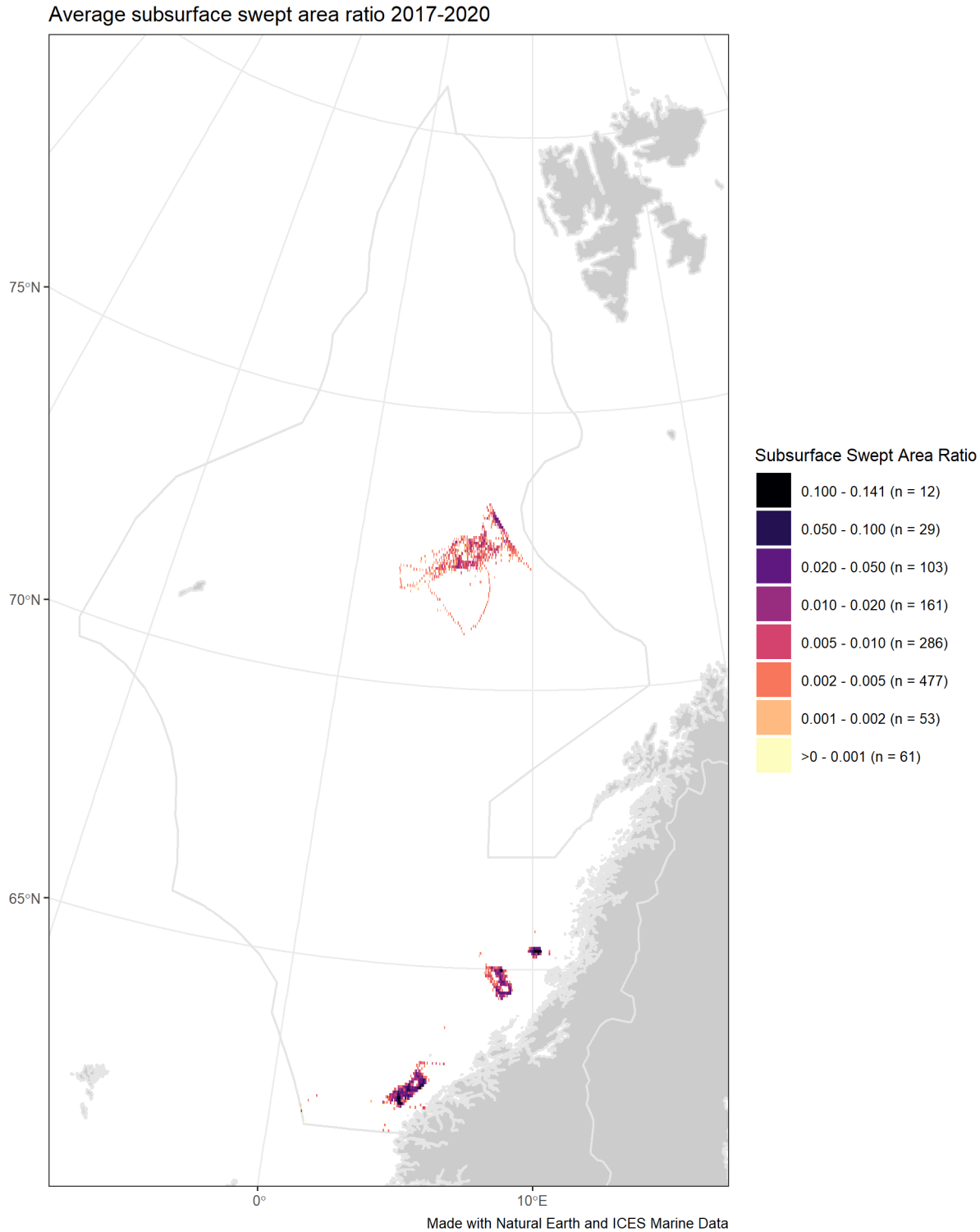


Figure 12 Average annual surface (top panel) and subsurface (bottom panel) disturbance by mobile bottom-contacting fishing gear (bottom otter trawls, bottom seines, dredges, beam trawls) in the Norwegian Sea, expressed as average swept-area ratios (SAR).

Bycatch of protected, endangered, and threatened species

Marine mammals that get entangled in fishing gear may drown or die later from injuries or from being partially entangled in parts from the fishing gear. In the Norwegian Sea, the largest bycatch of marine mammals occurs in the bottom set gillnet fisheries targeting cod and monkfish. Harbour porpoises, harbour seals, and grey seals are frequently killed in these

fisheries. Around 2000 harbour porpoises are taken in Norwegian commercial fisheries each year. Surveys of grey seals have shown a 50–60% reduction in pup production between 2007 and 2015 in mid-Norway, probably as a result of increased bycatches in gillnet fisheries for monkfish and cod. Bycatch of seals in coastal areas is uncertain (owing to unreliable species identification) but believed to be in the order of around 200 individuals per species. Bycatch of larger whales are less frequent. The number of bycatches of sperm whale and humpback whale in Norwegian fisheries are usually less than ten individuals annually (per species), and many of those are released alive.

Among the marine mammals, the blue whale, North Atlantic right whale, and the harbour porpoise are on the OSPAR list of threatened species in the Norwegian Sea. There is no quantification on the bycatch of these species at the ecoregion level, but as threatened species even a low number might be a significant problem.

The estimated annual bycatch of seabirds in gillnet fishery along the Norwegian coast during 2006–2015 was around 5000 (variability range 1580–11500) individuals, with domination of northern fulmar and common guillemot. Bycatch rate in offshore longlining for Greenland halibut is lower than in gillnet fisheries in coastal areas and mainly involves fulmars.

Several species of elasmobranchs in the ecoregion are considered endangered or threatened. Spurdog is one of the most frequent bycatches among the elasmobranchs; 1618 tonnes were landed from the Norwegian Sea in 2010–2020. The bycatch of porbeagle and basking shark amounted to 63 tonnes and 24 tonnes, respectively, for the same period. Flapper skate is part of the common skate complex (critically endangered), but species-specific data and status assessments are as yet missing.

Golden redfish in the Norwegian Sea is considered an endangered species. Although ICES has advised zero catch since 2017, catches have risen, mainly because of bycatch in the fishery for beaked redfish.

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Annex

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

Table A1 Status summary of the Norwegian Sea ecoregion stocks in 2020, in regards to the ICES maximum sustainable yield (MSY) approach and precautionary approach (PA) for stocks within the Norwegian Sea ecoregion. Grey represents unknown reference points. *For the MSY approach*: green represents a stock that is fished below F_{MSY} or whose size is greater than MSY $B_{trigger}$; red represents a stock status that is fished above F_{MSY} or whose size is less than MSY $B_{trigger}$. *For the PA*: green represents a stock that is fished below F_{pa} or whose size is greater than B_{pa}; yellow represents a stock that is fished between F_{pa} and F_{lim} or whose size is between B_{lim} and B_{pa}; red represents a stock that is fished above F_{lim} or whose size is less than B_{lim}. 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 name	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
aru.27.123a4	Greater silver smelt in subareas 1, 2, and 4, and in Division 3.a	Pelagic	3.2	2021	PA	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
bli.27.nea	Blue ling in Subareas 1, 2, 8, 9, and 12, and Divisions 3.a and 4.a	Demersal	5.3	2019	PA	?	✗	Maximum sustainable yield	?	✗	?	✗
								Precautionary approach	?	✗	?	✗
cod.27.1-2	Cod in subareas 1 and 2	Demersal	1	2021	MP	✗	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	o	✓	o	✓

Stock name	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
cod.27.2.coastS	Cod in Subarea 2 between 62Â°N and 67Â°N, southern Norwegian coastal cod	Demersal	3	2021	PA	?	✗	Maximum sustainable yield	✗	✗	✗	✗
								Precautionary approach	?	?	?	?
dgs.27.nea	Spurdog in subareas 1–10, 12, and 14	Elasmobranch	1.2	2020	MSY/PA	?	✗	Maximum sustainable yield	✓	✗	✓	✗
								Precautionary approach	✓	?	✓	?
ghl.27.1-2	Greenland halibut in subareas 1 and 2	Demersal	1	2021	PA	✗	?	Maximum sustainable yield	?	?	?	?
								Precautionary approach	✗	✓	✗	✓
had.27.1-2	Haddock in subareas 1 and 2	Demersal	1	2021	MP	✓	✗	Maximum sustainable yield	✗	✓	✗	✓
								Precautionary approach	✓	✓	✓	✓
her.27.1-24a514a	Herring in subareas 1, 2, 5 and divisions 4.a and 14.a, Norwegian spring-spawning herring	Pelagic	1	2021	MP	✗	✗	Maximum sustainable yield	✗	✓	✗	✓
								Precautionary approach	o	✓	o	✓

Stock name	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
hom.27.2a4a5b6a7a-ce-k8	Horse mackerel in Subarea 8 and divisions 2.a, 4.a, 5.b, 6.a, 7.a –c,e-k	Pelagic	1	2021	MSY	✗	✗	Maximum sustainable yield	✓	✗	✓	✗
								Precautionary approach	✓	o	✓	o
lin.27.1-2	Ling in subareas 1 and 2	Demersal	3.2	2021	PA	?	?	Maximum sustainable yield	✓	?	✓	?
								Precautionary approach	✓	?	✓	?
mac.27.nea	Mackerel in subareas 1–8 and 14 and division 9.a	Pelagic	1	2021	MSY	✓	✓	Maximum sustainable yield	✓	✓	✓	✓
								Precautionary approach	✓	✓	✓	✓
pok.27.1-2	Saithe in subareas 1 and 2	Demersal	1	2021	MP	✓	?	Maximum sustainable yield	?	?	?	?
								Precautionary approach	✓	✓	✓	✓
reb.27.1-2	Beaked redfish in subareas 1 and 2	Pelagic	1	2020	PA	?	?	Maximum sustainable yield	?	✓	?	✓
								Precautionary approach	✓	✓	✓	✓

Stock name	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
reg.27.1-2	Golden redfish in subareas 1 and 2	Demersal	1	2020	PA	✗	✗	Maximum sustainable yield	✗	?	✗	?
								Precautionary approach	?	✗	?	✗
whb.27.1-91214	Blue whiting in subareas 1–9, 12, and 14	Pelagic	1	2021	MP	✗	✗	Maximum sustainable yield	✗	✓	✗	✓
								Precautionary approach	o	✓	o	✓

Table A2 Stocks in the Norwegian Sea 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
bsf.27.nea	Black scabbardfish in subareas 1, 2, 4 –8, 10, and 14, and divisions 3.a, 9.a, and 12.b	*Aphanopus carbo*	Pelagic	3.2	2020	PA
bsk.27.nea	Basking shark in subareas 110, 12 and 14	*Cetorhinus maximus*	Elasmobranch	6.3	2019	PA
gfb.27.nea	Greater forkbeard in subareas 1–10, 12, and 14	*Phycis blennoides*	Demersal	3.2	2020	PA
por.27.nea	Porbeagle in subareas 1–10, 12, and 14	*Lamna nasus*	Elasmobranch	6.3	2019	PA
rjr.27.23a4	Starry ray in subareas 2 and 4, and Division 3.a	*Amblyraja radiata*	Elasmobranch	3.14	2019	PA
rng.27.1245a8914ab	Roundnose grenadier in subareas 1, 2, 4, 8, and 9, Division 14.a, and in subdivisions 14.b.2 and 5.a.2	*Coryphaenoides rupestris*	Demersal	6.2	2019	PA
usk.27.1-2	Tusk in subareas 1 and 2	*Brosme brosme*	Demersal	3.2	2021	PA

Table A3 Scientific names of species.

Common name	Scientific name
Atlantic puffin	*Fratercula arctica*
Baleen whale	*Mysticeti*
Basking shark	*Cetorhinus maximus*
Beaked redfish	*Sebastes mentella*
Black-legged kittiwake	*Rissa tridactyla*
Black scabbardfish	*Aphanopus carbo*
Blue ling	*Molva dypterygia*
Blue whale	*Balaenoptera musculus*
Blue whiting	*Micromesistius poutassou*
Bottlenose whale	*Hyperoodon ampullatus*
Capelin	*Mallotus villosus*
Cod	*Gadus morhua*
Common guillemot	*Uria aalge*
European eel	*Anguilla anguilla*
Flapper skate	*Dipturus intermedius*
Golden redfish	*Sebastes norvegicus*
Greater forkbeard	*Phycis blennoides*
Greenland halibut	*Reinhardtius hippoglossoides*
Greater silver smelt	*Argentina silus*
Grey seal	*Halichoerus grypus*
Haddock	*Melanogrammus aeglefinus*
Harbour porpoise	*Phocoena phocoena*
Harbour seal	*Phoca vitulina*
Harp seal	*Pagophilus groenlandicus*
Herring	*Clupea harengus*
Hooded seal	*Cystophora cristata*
Horse mackerel	*Trachurus trachurus*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Ling	*Molva molva*
Long nosed skate	*Dipturus oxyrinchus*

Common name	Scientific name
Long rough dab	*Hippoglossoides platessoides*
Mackerel	*Scomber scombrus*
Minke whale	*Balaenoptera acutorostrata*
Monkfish	*Lophius* sp.
Northern fulmar	*Fulmarus glacialis*
North Atlantic right whale	*Eubalaena glacialis*
Plaice	*Pleuronectes platessa*
Porbeagle	*Lamna nasus*
Rabbit fish	*Chimaera monstrosa*
Rays and skates	*Rajidae*
Redfish	*Sebastes* sp.
Roundnose grenadier	*Coryphaenoides rupestris*
Round ray	*Rajella fyllae*
Saithe	*Pollachius virens*
Sole	*Solea solea*
Sperm whale	*Physeter microcephalus*
Spinytail skate	*Bathyraja spinicauda*
Spurdog (Picked dogfish, spiny dogfish)	*Squalus acanthias*
Thornback ray	*Raja clavata*
Starry ray	*Amblyraja radiata*
Tusk	*Brosme brosme*
Velvet-belly lanternshark	*Etmopterus spinax*
Whiting	*Merlangius merlangus*
Wrasse	*Labrus* spp.