9.2 Greater North Sea ecoregion – Fisheries overview, including mixed-fisheries considerations

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Executive summary

This fisheries overview contains details of mixed fisheries considerations for North Sea demersal and Norway lobster stocks, and a description of the fisheries and their interactions within the ecoregion.

Mixed-fisheries considerations presents six example scenarios of fishing opportunities of eight fish stocks and ten Norway lobster stock units fished within the ecoregion: cod (cod.27.47d20), haddock (had.27.46a20), whiting (whg.27.47d), saithe (pok.27.3a46), plaice (ple.27.420 and ple.27.7d), sole (sol.27.4), turbot (tur 27.4), witch (wit.27.3a47d), and Norway lobster (functional units [FUs] 5–10, 32, 33, 34, and 4 outFU), taking into account the single-stock advice of those species. The most limiting total allowable catch (TAC) in 2020 will be the TAC for cod for particular fleets.

Around 6600 fishing vessels are active in the Greater North Sea. Total landings peaked in the 1970s at 4 million tonnes and have since declined to about 2 million tonnes. Total fishing effort has declined substantially since 2003. Pelagic fish landings are greater than demersal fish landings. Herring and mackerel, caught using pelagic trawls and seines, account for the largest portion of the pelagic landings, while sandeel and haddock, caught using otter trawls/seines, account for the largest fraction of the demersal landings. Catches are taken from more than 100 stocks. Discards are highest in the demersal and benthic fisheries. The spatial distribution of fishing gear varies across the Greater North Sea. Static gear is used most frequently in the English Channel, the eastern part of the Southern Bight, the Danish banks, and in the waters east of Shetland. Bottom trawls are used throughout the North Sea, with lower use in the shallower southern North Sea where beam trawls are most commonly used. Pelagic gears are used throughout the North Sea.

In terms of tonnage of catch, most of the fish stocks harvested from the North Sea are being fished at levels consistent with achieving good environmental status (GES) under the EU's Marine Strategy Framework Directive; however, the reproductive capacity of the stocks has not generally reached this level. Almost all the fisheries in the North Sea catch more than one species; controlling fishing on one species therefore affects other species as well. ICES has developed a number of scenarios for fishing opportunities that take account of these technical interactions. Each of these scenarios results in different outcomes for the fish stocks. Managers may need to take these scenarios into account when deciding upon fishing opportunities. Furthermore, biological interactions occur between species (e.g. predation) and fishing on one stock may affect the population dynamics of another. Scenarios that take account of these various interactions have been identified by ICES and can be used to evaluate the possible consequences of policy decisions. The greatest physical disturbance of the seabed in the North Sea occurs by mobile bottom-contacting gear during fishery in the eastern English Channel, in nearshore areas in the southeastern North Sea, and in the central Skagerrak. Incidental bycatches of protected, endangered, and threatened species occur in several North Sea fisheries, and the bycatch of common dolphins in the western English Channel may be unsustainable in terms of population.

Introduction

The Greater North Sea ecoregion includes the North Sea, English Channel, Skagerrak, and Kattegat. The Greater North Sea is a relatively shallow sea on the European continental shelf, with the exception of the Norwegian Trench that extends parallel to the Norwegian shoreline, from Oslo to north of Bergen. Pelagic species (primarily herring and mackerel) account for a significant portion of the total commercial fish landings in the region. Landings of benthic and demersal finfish species (primarily haddock, sandeel, flatfish, and cod) are also significant.

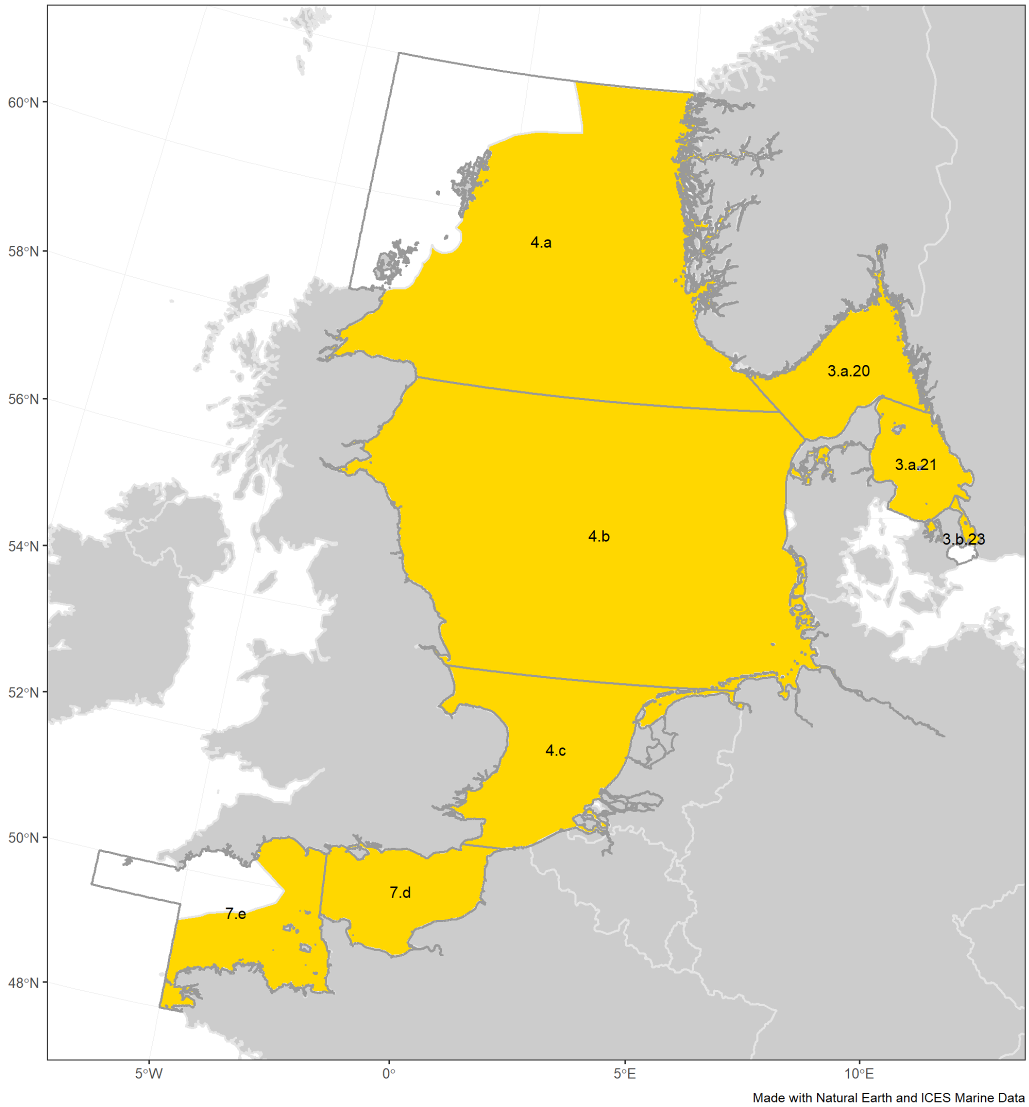


Figure 1 The Greater North Sea ecoregion (highlighted in yellow) .

All of the Greater North Sea ecoregion lies within the FAO Major Fishing Area 27; the prefix "27" in the ICES statistical area codes is therefore omitted in the following. This overview covers ICES Division 3.a, most of divisions 4.a, 4.b, 4.c, 7.d, and part of 7.e, as well as Subdivision 3.b.23.

The overview does not include the fisheries in the western English Channel (Division 7.e) and in the Sound (south of Subdivision 3.a.21).

Mixed-fisheries considerations

Mixed-fisheries considerations are based on the single-stock assessments, combined with information on catch composition and fishing effort of the demersal fleets and fisheries in the Greater North Sea. These catch cod (cod.27.47d20), haddock (had.27.46a20), plaice (ple.27.420 and ple.27.7d), saithe (pok.27.3a46), sole (sol.27.4), turbot (tur.27.4), whiting (whg.27.47d), witch (wit.27.3a47d), and Norway lobster (functional units [FUs] 5–10, 32, 33, 34, and Subarea 4 outside of the FUs). In the absence of specific mixed-fisheries management objectives, ICES does not advise on specific mixed-fisheries catch opportunities for the individual stocks. The mixed-fisheries results shown for Norway lobster are combined in plots for several FUs, but stock status and fishing opportunities differ across FUs.

Mixed-fisheries scenarios are based on central assumptions that fleet fishing patterns and catchability in 2020 and 2021 are the same as those in 2019 (similar to procedures in single-stock forecasts, where factors such as growth and selectivity are assumed constant). In 2019, fleet stock shares were defined using the realized national quota uptake. For the mixed-fisheries advice in 2020, each fleet's stock share is based on its respective historical catches.

Mixed-fisheries projections are presented in terms of catch (projected landings and discards). The most limiting stock for fishing effort will be cod for particular fleets (the "cod-ns" scenario), corresponding to an undershoot for the advised catch for the other stocks considered in the mixed-fisheries analysis. A substantial overshoot of advised catch can occur under other scenarios (e.g. the "max" scenario).

For demersal stocks that have the F_{MSY} range available, a "range" scenario is presented that minimizes the potential mismatches of advised catch in 2021 within the F_{MSY} range. This scenario estimates the fishing mortality (F) by stock which, if used for setting single-stock fishing opportunities for 2021, may reduce the gap between the most and the least restrictive advised catch, thus reducing the potential for quota overshoot and undershoot. This "range" scenario suggests that the potential for mixed-fisheries mismatch would be lowered with a 2021 TAC in the lower part of the F_{MSY} range for haddock, plaice, saithe, and sole, and at the highest possible value for cod in accordance with the maximum sustainable yield (MSY) approach and the MAP (EU multiannual plan).

The potential for quota overshoot and undershoot linked to the most and the least restrictive single-stock fishing opportunities for 2021 is presented in Figure 2. Six projections are presented, corresponding to different fleet scenarios for 2020 and 2021 (Table 1). Norway lobster stocks are not yet included in the "range" scenario.

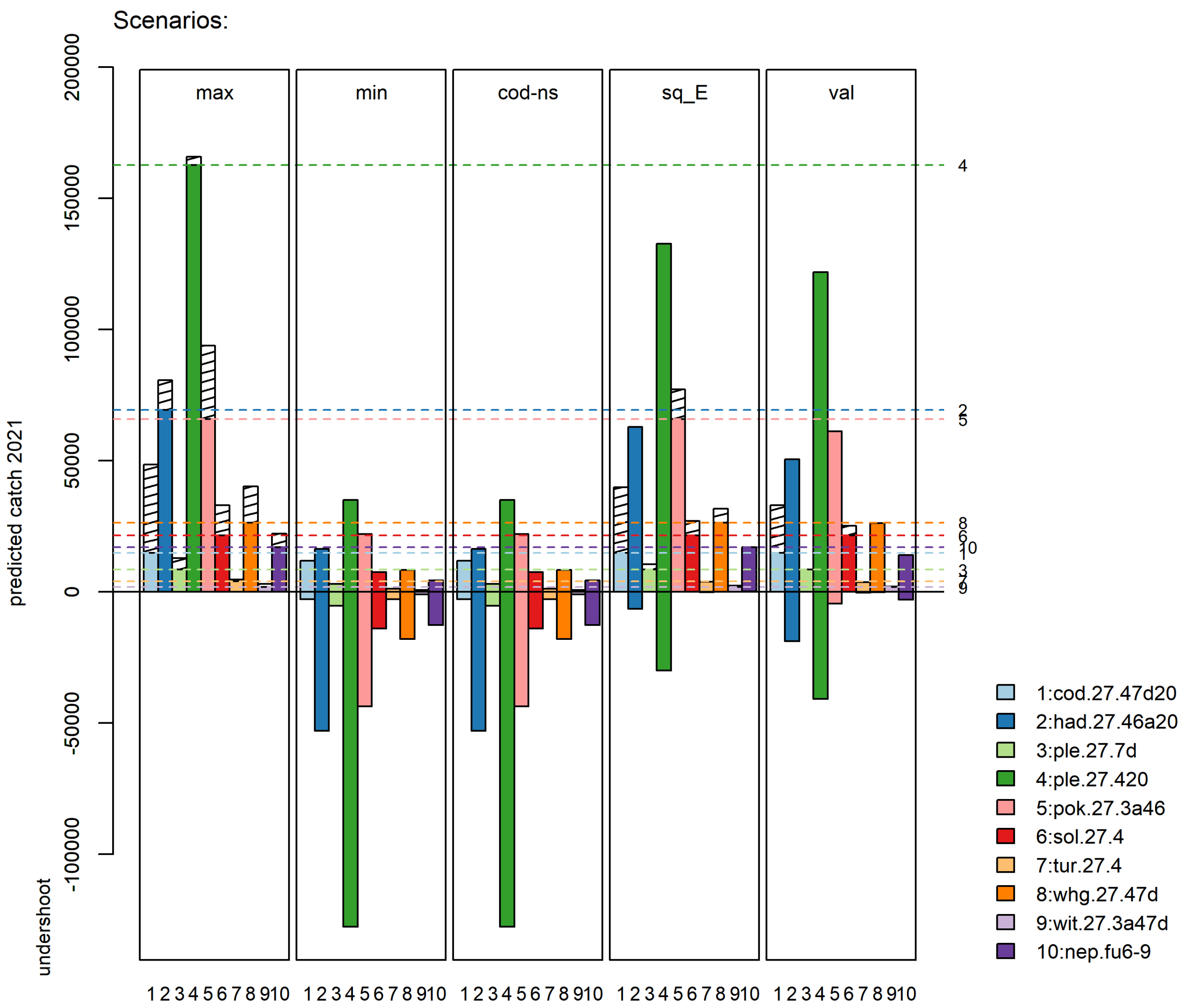


Figure 2 Mixed-fisheries projections for the North Sea. Estimates of potential catches (in tonnes) by stock and by scenario. The horizontal lines correspond to the single-stock catch advice for 2021. Bars below the value of zero show undershoot (compared to single-stock advice) where catches are predicted to be lower when applying the scenario. Hatched columns represent catches that overshoot the single-stock advice. For full stock names, see Table A1 in the Annex.

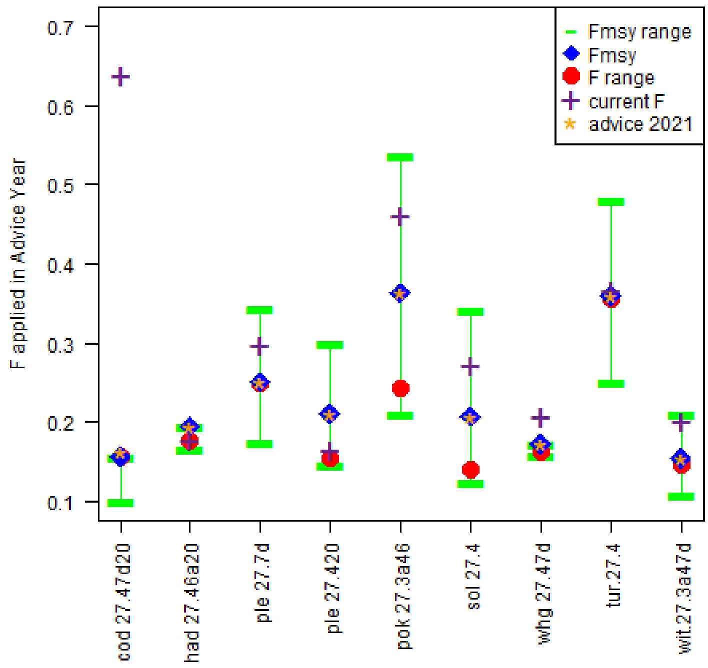


Figure 3 Mixed fisheries for the North Sea. North Sea mixed-fisheries 2021 "range" fishing mortality within the F_{MSY} range, compared with F_{MSY}, the current F (2019), and F in the single-stock advice for 2021. For cod in the North Sea, F_{MSY} ranges are limited in accordance with the MSY approach and the MAP when the cod SSB is below MSY $B_{trigger}$.

Table 1 Mixed fisheries for the North Sea. Mixed-fisheries scenarios for the North Sea stocks.

Scenario code	Scenarios
max	**"Maximum":** For each fleet, fishing effort in 2021 stops when all stock shares* of that fleet have been caught. This option causes overfishing of the single-stock advice possibilities of most stocks.
min	**"Minimum":** The underlying assumption is that fishing stops for a fleet when the fleet's catch of the first quota species for that fleet meets the corresponding single-stock exploitation boundary. This option causes underutilization of the single-stock advice possibilities of other stocks. This scenario can highlight some potential "choke species" issues.
sq_E	**"*Status quo* effort":** The effort of each fleet in 2021 is set equal to the effort in the most recent year for which landings and discard data are available (2019).
val	**"Value":** A simple scenario accounting for the economic importance of each stock for each fleet. The effort by fleet is equal to the average effort required to catch the fleet's stock shares of each of the stocks, weighted by the historical catch value of that stock (see example further below). This option causes overfishing of some stocks and underutilization of others.
cod-ns	**"Cod MSY approach":** All fleet efforts in 2021 correspond to effort needed to take their cod stock share, regardless of other catches. (There are small differences in the cod catches between this scenario and the single-stock advice because of the slightly different forecast methods used.) This option is the most precautionary option, causing underutilization of the single-stock advice possibilities of other stocks. This scenario can highlight some potential "choke species" issues.
range	**"range":** estimates a fishing mortality by stock (using the F_{MSY} ranges) which, if used for setting single-stock fishing opportunities, may reduce the gap between the most and least restrictive TACs, thus reducing the potential for quota over- and undershoot. F_{MSY} ranges are limited in accordance to the MSY approach and the MAP for stocks below MSY $B_{trigger}$.

* Throughout this document, the term "fleet's stock share" or "stock share" is used to describe the share of the fishing opportunities for each particular fleet, calculated based on the single-stock advice for 2021 and the historical proportion of the stock landings taken by the fleet (2019).

Catch scenarios

Mixed-fisheries advice considers the implications of mixed fisheries operating under single-stock TAC regimes, taking into account the fishing patterns of the various fleets in 2019. The scenarios presented do not assume any adaptation of fishing behaviour.

The ICES single-stock catch advice for demersal stocks in 2021 is based on either existing management plans, the ICES MSY approach, or the ICES precautionary approach (PA). Mixed-fisheries catch scenarios can take specific management priorities into account. These catch scenarios are described in Table 1. The resulting catch by scenario in the advice year (2021) is provided in Table 2, along with the single-stock advice for reference. The resulting F_{total} value for 2021 is shown in Table 3 and spawning-stock biomass (SSB) at the beginning of 2022 is shown in Table 4. Scenario results show that it is not possible to achieve all management objectives simultaneously under the current fishing patterns. For instance, if decreasing fishing mortality for cod is the major objective and fleets stop fishing after exhaustion of their cod TAC, this would mean that the TAC for other species in the mixed fisheries may not be fully utilized. As a consequence, scenarios that result in under- or overutilization are useful in identifying the main mismatches between the fishing opportunities for the various stocks, where limiting TACs can create potential “choke species” effects at fleet level. Such scenarios indicate the direction in which fleets may have to adapt to fully utilize these catch opportunities without increasing the risk of unwanted catch.

Cod continues to be the most limiting stock in the Greater North Sea mixed-fisheries model. The cod SSB for 2020 is estimated to be below B_{lim}, with advised catch rates for 2021 in order to achieve an SSB > B_{lim} in 2022 well below F_{MSY}. For 2021, the "min" scenario results in a constraint by cod to 39 out of 40 fleet segments (Figure 4). For the one remaining fleet, plaice in the eastern English Channel is constraining. Conversely, in the “max” scenario, haddock, North Sea plaice, and eastern English Channel plaice would be the least limiting for three, 27, and one fleet segments, respectively. Finally, if Norway lobster were managed by separate TACs, Norway lobster in FU 7 would be the least limiting for nine fleet segments. The most and the least limiting species per fleet are shown in Figure 4.

The "range" scenario (Ulrich *et al.*, 2017) searches for the minimum sum of differences between potential catches by stock under the “min” and “max” scenarios within the F_{MSY} ranges. This “range” scenario suggests that the potential for mixed-fisheries mismatch would be lowered with a 2021 TAC in the lower part of the F_{MSY} range for North Sea plaice, saithe, and sole, and at the highest possible value for cod in accordance with the MSY approach and the EU multiannual plan (MAP; EU, 2018). The outcome of this scenario is largely driven by differences between the current F for cod and the highest possible F in the adjusted range for cod (Figure 3), which implies that most fleets would need to reduce their effort to avoid overshooting the single-species advice for this stock. Because the “range” scenario is constrained by the single-stock MSY ranges (or reduced ranges), the catches forecasted within this scenario could only be achieved with substantial changes in fishing patterns.

ICES single-stock advice follows the ICES MSY approach or, in the cases of sol.27.4 and ple.27.7d, the MAP. To be consistent with these objectives, a scenario that delivers at least the SSB and/or F objectives of the single-stock advice simultaneously for all stocks is considered necessary. This is achieved in the “min” scenario, which assumes that fleets stop fishing when their first stock share is exhausted, regardless of the actual importance of this stock share for the fleet. This scenario reflects the “choke species” effect that may result from a strictly implemented landing obligation without adaptation of the fleets. The total fishing effort in 2021 would need to be reduced by 75% compared to the 2019 level to comply with this scenario, consistent with the reductions in fishing mortality advised for cod.

In contrast to the “min” scenario, the “max” scenario demonstrates the upper bound of potential fleet effort and stock catches. Clearly, the assumption that all fleets continue fishing until all their stock shares are exhausted irrespective of the economic viability of such actions does not make it a plausible scenario. Its purpose is mainly to illustrate where the imbalance lies. The different fleets have different opportunities and incentives for 2020 and 2021, depending on their historical catch composition and selectivity, as well as the differences in productivity across the various stocks they exploit. In 2021 the fleets catching any amount of Norway lobster, haddock, and plaice would have to increase their effort on average by 27% to achieve their stock shares for these stocks, which would lead to potential overshoots of their shares for other stocks. This is an unrealistic outcome for such fleets, especially considering that the TAC for plaice is not fully taken at present (total catches were around 70% of the catch advice in 2019).

Two intermediate scenarios reflect alternative mixed-fisheries hypotheses: “sq_E” and "val". The *status quo* “sq_E” scenario sets the effort of each fleet in 2020 and 2021 equal to the effort in the most recent year for which data are available (2019). This scenario investigates the mixed-fisheries outcomes if the situation remains the same in terms of total effort and fishing behaviour. This scenario shows a 2021 TAC overshoot for cod, eastern English Channel plaice, saithe, sole, whiting, and witch and a 2021 TAC undershoot for haddock, North Sea plaice, and turbot. In the absence of a full economic behaviour model, a “val” scenario was run that balances fishing opportunities by stock with their potential market value. This scenario usually predicts effort levels closer to the realised effort than the “min” and “max” scenarios (Ulrich *et al.*, 2011). For 2021, the “val” scenario estimates catches close to the *status quo* “sq_E” scenario, except for the 2021 TAC undershoot for saithe.

This year, a “cod-ns” scenario is presented. This scenario reflects the fishing mortality corresponding to the single-stock advice for cod (based on the ICES MSY approach), and presents resulting catches for other stocks in a mixed-fisheries context.

Table 2 Mixed fisheries for the North Sea. Catch per mixed-fisheries scenario 2021, in tonnes.

Stock	Single-stock catch advice (2021) *	Catch per mixed-fisheries scenario (2021)					Range^
		max	min	cod-ns	sq_E	val	
cod.27.47d20	14755	48449	11815	11815	39809	32992	11773
had.27.46a20	69280	80540	16224	16224	62697	50353	62395
ple.27.7d	8402**	12779	2929	2965	10481	8478	8335
ple.27.420	162607	165737	34936	34936	132528	121687	123819
pok.27.3a46	65687	93808	21876	21876	77021	61082	44099
sol.27.4	21361**	32843	7355	7355	26849	25037	13793
tur.27.4	3948***	4537	1066	1066	3735	3512	3477
whg.27.47d	26304	40030	8287	8287	31571	26093	25102
wit.27.3a47d	1733	2901	610	610	2288	1889	1680
nep.fu.5	1570	1405	266	266	1075	886	NA
nep.fu.6	2310**	5453	1036	1036	4189	2596	NA
nep.fu.7	9579**	9360	1766	1766	7139	6363	NA
nep.fu.8	3931**	5352	1013	1013	4094	3671	NA
nep.fu.9	1180**	1926	366	366	1479	1298	NA
nep.fu.10	46	63	12	12	48	40	NA
nep.fu.32	381	516	98	98	395	326	NA
nep.fu.33	956	1303	247	247	997	821	NA
nep.fu.34	566	722	137	137	553	455	NA
nep.27.4outFU	301	410	78	78	314	259	NA

NA: stocks for which ranges of F_{MSY} are either not available or not yet included in the scenario.
* Advised catches of no more than the indicated value.
** Single-stock advice based on F ranges in accordance with the EU MAP for demersal stocks in the North Sea (EU, 2018). The value presented here is for catches corresponding to F_{MSY}.
*** Corresponding to (projected landings) / (1 –average discard rate), Projected landings = 3514 and average discard rate = 11.0%. Catches per mixed-fisheries scenario correspond to projected landings.
^ The results of the “range” scenario are bounded by the single-stock MSY ranges (or reduced ranges) and do not directly account for any technical interactions. These catches could only be achieved with substantial changes in fishing patterns.

Table 3 Mixed fisheries for the North Sea. F_{total} resulting from single-stock advice and different mixed-fisheries scenarios. Norway lobster are not included as management is not applied at the functional unit level.

Stock	Single-stock advice	F_{total} (2021) resulting from mixed-fisheries scenarios applied in 2021					Range*
	F_{total} (2021)	max	min	cod-ns	sq-E	val	
cod.27.47d20	0.162	0.831	0.158	0.158	0.638	0.504	0.155
had.27.46a20	0.194	0.229	0.043	0.043	0.175	0.139	0.176
ple.27.7d	0.250	0.415	0.083	0.084	0.329	0.258	0.248
ple.27.420	0.210	0.212	0.041	0.041	0.166	0.151	0.154
pok.27.3a46	0.363	0.589	0.114	0.114	0.460	0.350	0.242
sol.27.4	0.207*	0.344	0.067	0.067	0.272	0.251	0.139
tur.27.4	0.360	0.513	0.100	0.100	0.402	0.373	0.355
whg.27.47d	0.172	0.270	0.052	0.052	0.208	0.170	0.162
wit.27.3a47d	0.154	0.268	0.051	0.051	0.205	0.166	0.145

Legend:

- $F_{2021} \leq F_{MSY}$
- $F_{MSY} < F_{2021} < F_{pa}$
- $F_{2021} > F_{pa}$
- $F_{2021} > F_{lim}$

Notes:
* Single-stock advice is based on F ranges in accordance with the EU MAP for demersal stocks in the North Sea (EU, 2018). The value presented here is F_{MSY}.

Table 4 Mixed fisheries for the North Sea. SSB results from single-stock advice and different mixed-fisheries scenarios. Norway lobster are not included as the abundance is not forecasted in the mixed-fisheries model. All weights are in tonnes. Unless otherwise noted, SSB (2022) > B_{pa} or MSY $B_{trigger}$.

Stock	Single-stock advice	SSB (2022) resulting from mixed-fisheries scenario applied in 2021					Range
	SSB (2022)	max	min	cod-ns	sq_E	val	
cod.27.47d20	112758	55628	91343	91343	63683	70219	92399
had.27.46a20	471256	464775	530327	530327	482834	495386	476545
ple.27.7d	39205	33218	44543	44501	35800	38083	39281
ple.27.420	1374316	1372812	1498206	1498206	1404518	1414888	1412848
pok.27.3a46	164624	128885	193128	193128	143579	157714	172944
sol.27.4	86119^	74573	98037	98037	80077	81742	86210
tur.27.4	9449	7962	11759	11759	8827	9069	9490
whg.27.47d	185094	173556	196669	196669	179644	183615	185597
wit.27.3a47d	5476	4527	5644	5644	4823	5017	5150

Legend:

- $SSB_{2022} > B_{pa}$ or MSY $B_{trigger}$
- $SSB_{2022} > B_{lim}$, no B_{pa} defined
- $B_{lim} < SSB_{2022} < B_{pa}$
- $SSB_{2022} < B_{lim}$

Notes:
^ Single-stock advice is based on ranges in accordance with the EU MAP for demersal stocks in the North Sea (EU, 2018). The value presented here is the SSB (2022), corresponding to fishing at F_{MSY} in 2021.

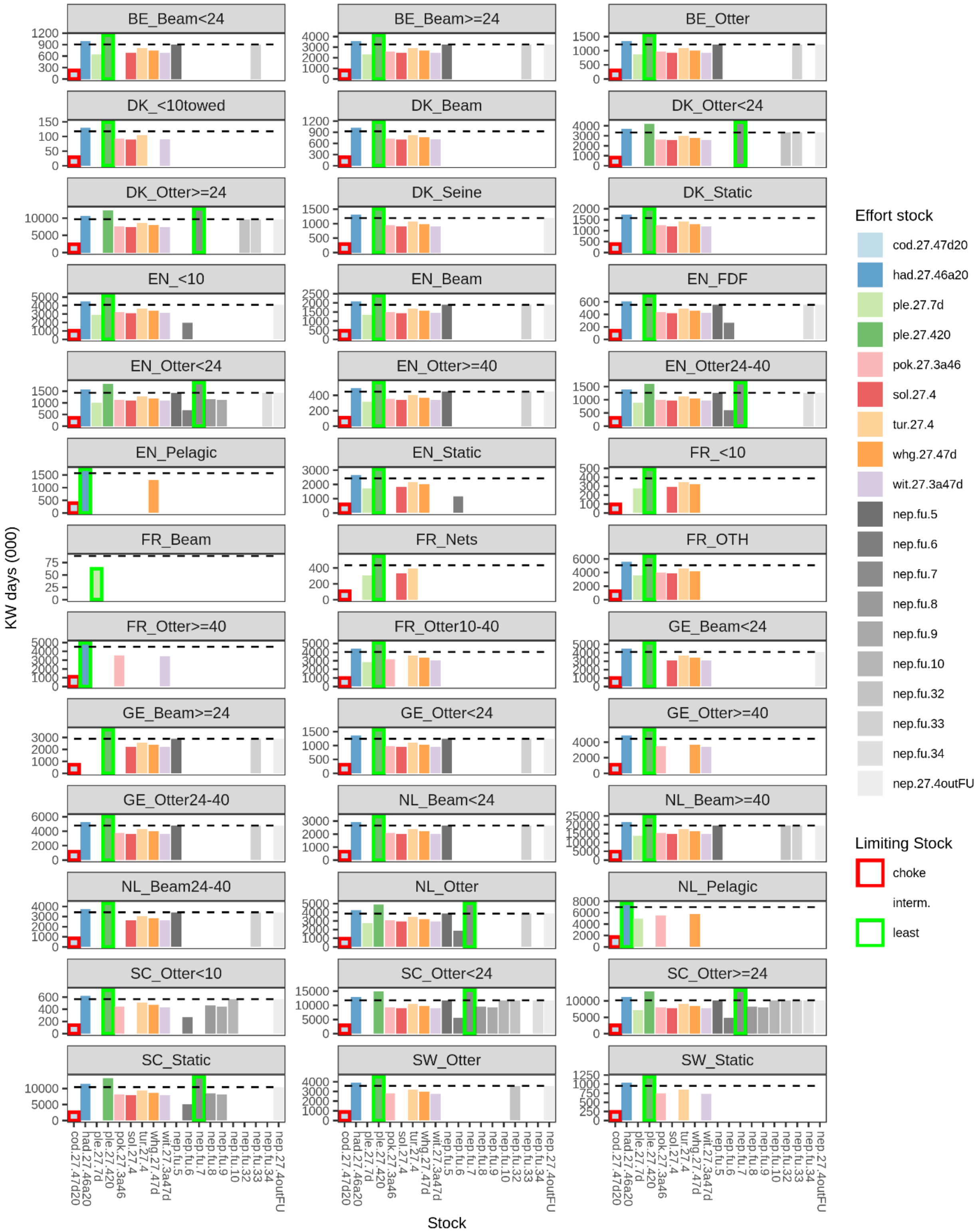


Figure 4 Mixed fisheries for the North Sea. Estimates of effort by fleet needed to reach each single-stock advice. Stocks are coded by colour, with the most limiting stock ("choke species") for each fleet in 2021 highlighted with a red border and the least limiting species highlighted with a green border. Fleet names are given by country, main gear, and vessel size (m). The *status quo* effort for each fleet (2019 values) is shown as a dashed line for reference.

Quality considerations

Mixed-fisheries projections are based on single-stock assessments. Single-stock forecasts are also reproduced independently as part of mixed-fisheries analyses, allowing additional quality control of both processes. Due to methodological differences between the SAM stochastic forecasts conducted during ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) for several stocks (i.e. saithe, cod, witch) and the deterministic forecast done within MIXFISH, some discrepancies are to be expected between the single-stock advice and the baseline run reproducing this advice at WGMIXFISH. For haddock and whiting, the single-stock advice is based on a multifleet deterministic forecast (taking into account the selectivity of the human consumption fleet and the industrial fleet), which also leads to differences with the single-fleet forecast used by WGMIXFISH. Despite these methodological differences, the differences observed this year were small (< 5%) for all stocks, and the WGMIXFISH deterministic forecast was considered close enough to the single-stock advice to be used as a basis for the mixed-fisheries projections.

It is not possible to include eastern English Channel sole in the mixed fisheries analysis this year because the assessment was downgraded to Category 3.

Data provided on catches (landings and discards) and effort are disaggregated by métier. Age and length distributions by stock for all fleets and métiers are available for the most recent years. In spite of the improvements made over time, and in particular the issuing of a specific data call, the compilation of the mixed-fisheries dataset remains a highly demanding process, combining several types of data provided by different sources and covering a large number of countries, stocks, and fishing activities. Various changes and updates in the data sources occur every year; quality control is a major component of the work performed, and considered necessary for providing advice.

Norway has not provided effort information since 2016 so Norwegian fleets are now included in the “Other fleets” segment (OTH_OTH in the model). Norway mainly contributes to North Sea cod and saithe catches (around 15% and 45%, respectively).

A key assumption in the projections is that catchability by stock, métier, and effort distribution (relative proportion of time spent by each fleet in the various métiers) in 2020 and 2021 remain the same as 2019. In reality, fishing patterns may change over time – particularly in response to significant changes in policy, such as the implementation of the landing obligation and revision of technical measures. In practice, such changes could affect the outcomes of mixed-fisheries projections. The year range used as a recent mean (2017–2019) covers the period during which the EU landing obligation has been introduced so the data reflect changes in fishing pattern over this period. It has not been possible to predict further changes in fishing pattern over the projection period.

Table 5 Mixed fisheries in the North Sea. The basis of the assessment.

Stock data category	Categories 1, 4, and 5 (ICES, 2019a).
Assessment type	F_{cube} (FLR)
Input data	Assessments on the relevant stocks in the North Sea fisheries working group (WGNSSK; ICES, 2019b); catch and effort by fleet and métiers.
Discards and bycatch	Included as in the single-stock assessments.
Indicators	None.
Other information	
Working groups	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)

Methods and data

Mixed-fisheries considerations are based on the single-stock assessments combined with knowledge on the species composition in catches in the Greater North Sea fisheries, using the F_{cube} method (Ulrich *et al.*, 2011, 2017). Mixed-fisheries scenarios are based on the central assumptions that fishing patterns of fleets (quota shares per stock, effort allocation to different métiers) and catchability in 2020 and 2021 are the same as those in 2019.

The species considered here as part of the demersal mixed fisheries are cod, haddock, whiting, saithe, plaice, sole, turbot, witch (for the first time), and Norway lobster. Nine of the stocks are assessed with analytical assessments. In addition, ten Norway lobster stocks for which quantitative advice is provided but not catch forecasts, are included. There are differences between stock areas, management areas, and management rules (MSY approach or MAP) for the stocks considered here. Table 6 summarizes the advice area, management area, and management plan for the main stocks. Figure 6 illustrates the landings by gear-grouping and species. Table 7 describes the gear-groupings used in the forecast for the different scenarios.

The projections are presented in terms of total catches. All stocks have been under the landing obligation since 2019, and all catches for these species are assumed to count against the fleets' stock shares each year.

In the 2019 MIXFISH advice, the assumptions for the MIXFISH scenarios for the North Sea were modified to more realistically reflect choke situations, i.e. when one or more national quotas are fully utilized, all fishing will cease for that country. If a country has unused quota for a given stock, that stock shall not be estimated to be a choke species for the fleets of that country and should not be limiting in the "min" scenario. This adjustment was made at country scale as it was the only scale at which quota consumption data were available. This hypothesis also implied that when a quota was not consumed at the scale of the country, no fleet was limited and quota reallocation occurred at the national scale, whereas no quota reallocation occurred between countries. To forecast catches, recent catchability and fishing mortality are calculated by national fleet. For this year's advice, this assumption was not used as it resulted in inconsistent results for the "range" scenario with F_{range} close to F_{upper} for eastern English Channel plaice, saithe, and sole.

Fleet and métier categories used in the mixed-fisheries analysis are based on EU Data Collection Framework (DCF) level 6 categories, which are subsequently translated into the gear groups from the 2008 EU cod management plan (EU, 2008). The "non-allocated" category collects the difference between the total landings used in the single-stock assessments and the sum of the landings allocated to all fleets and métiers. From 2017, this "non-allocated" part became very large as it includes all Norwegian landings for which effort data was not provided and which could therefore not be defined as fleets. The "Other" métier sums up the landings of all "small" métiers (i.e. all métiers landing less than 1% in 2017 for all the stocks considered). Both the "Other" and the "non-allocated" métiers are afterwards merged into the "OTH-OTH" fleet in the model.

Total landings (2019) of all species considered in the mixed-fisheries advice were 211 417 tonnes, with:

- ~ 75% landed by otter trawls and demersal seines;
- ~ 18% by beam trawls;
- ~ 2% by gillnets and trammelnets;
- ~ < 1% by longlines; and
- ~ 4% by other gears.

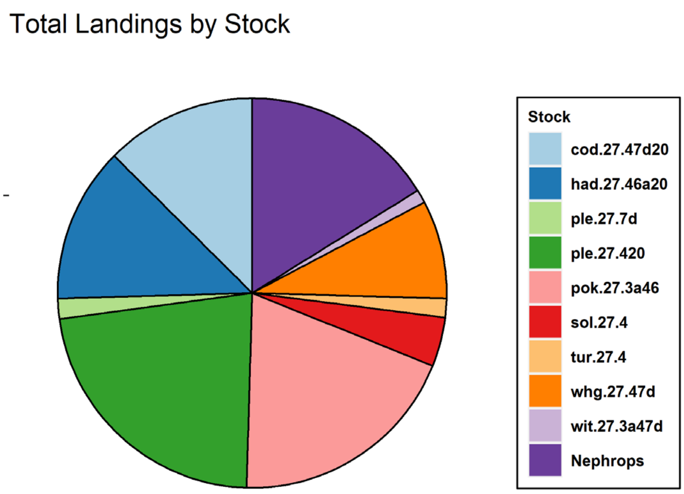


Figure 5 Mixed fisheries for the North Sea. Landings distribution by species: cod.27.47d20 (13%), had.27.46a20 (13%), ple.27.7d (2%), ple.27.420 (22%), pok.27.3a46 (19%), sol.27.4 (4%), tur.27.4 (2%), whg.27.47d (8%), wit.27.3a47d (1%), Nephrops (16%).

Table 6 Mixed fisheries for the North Sea. Advice, management areas, and management plans for the species considered.

Species	ICES single-stock advice area	Management area	EU Management plan ref(s)
Cod	Subarea 4, Division 7.d, and Subdivision 3.a.20 (North Sea, eastern English Channel, Skagerrak)	EU TAC Skagerrak EU TAC Division 7.d Subarea 4; EU waters of Division 2.a; the part of Division 3.a that is not covered by the Skagerrak and Kattegat	EU (2018)
Haddock *	Subarea 4, Division 6.a, and Subdivision 3.a.20 (North Sea, West of Scotland, Skagerrak)	EU TAC Division 3.a, EU waters of divisions 3.b, 3.c, and 3.d Subarea 4; EC waters of Division 2.a EU and international waters of divisions 5.b and 6.a	EU (2018)
Plaice **	Subarea 4 (North Sea) and Subdivision 3.a.20 (Skagerrak)	Subarea 4; EU waters of Division 2.a; the part of Division 3.a that is not covered by the Skagerrak and the Kattegat	EU (2019)
Saithe	Subareas 4 and 6 and Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	Division 3.a and Subarea 4; EU waters of divisions 2.a, 3.b, 3.c, and 3.d Subarea 4; EU waters of Division 5.b; EU and international waters of subareas 12 and 14	EU (2018)
Sole	Subarea 4 (North Sea)	EU waters of subareas 2 and 4	EU (2018)
Turbot	Subarea 4 (North Sea)	EU waters of subareas 2 and 4	EU (2018)
Whiting ***	Subarea 4 and Division 7.d (North Sea and eastern English Channel)	Subarea 4 EU TAC divisions 7.b–k	EU (2018)
Norway lobster	Functional units (FUs) in Subarea 4: 5, 6, 7, 8, 9, 10, 32, 33, 34, and other areas outside FUs	EU TAC Subarea 4 Norway: no TAC	EU (2018)
Plaice	Division 7.d (eastern English Channel)	Divisions 7.d and 7.e	EU (2019)

* Prior to 2014 this stock was only assessed for Subarea 4 and Subdivision 3.a.20.
** Prior to 2015 this stock was only assessed for Subarea 4 (North Sea).
*** Advice for this stock includes human consumption and industrial landings.

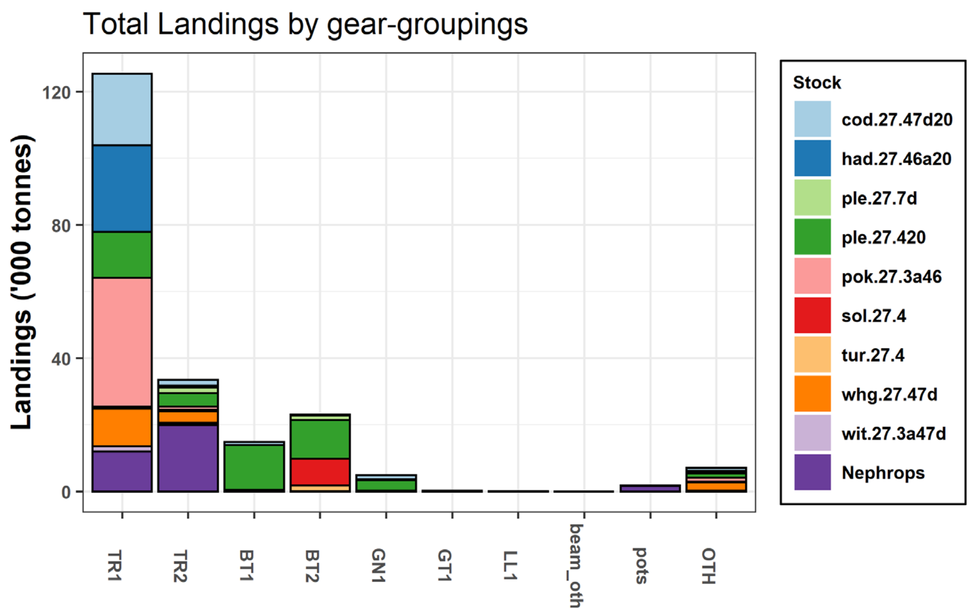


Figure 6 Mixed fisheries for the North Sea. Landings distribution of species by gear-grouping in 2019 (list of gear-groupings are available in Table 7). Note: The "other" (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort (Including all Norwegian fleets) and (ii) landings of any combination of fleet and gear with landings < 1% of any of the stocks in 2019. The "non allocated" is the differences between total landings used in the single-stock advice and mixed-fisheries advice.

Table 7 Mixed fisheries in the North Sea. Gear-groupings used to define fleets for mixed-fisheries analysis.

Gear-groupings	Gear	Mesh size
TR1	Otter trawl or demersal seine	≥ 100 mm
TR2	Otter trawl or demersal seine	≥ 70 mm and < 100 mm
BT1	Beam trawl	≥ 120 mm
BT2	Beam trawl	≥ 80 mm and < 120 mm
GN1	Gillnets	All possible mesh sizes
GT1	Trammelnets	All possible mesh sizes
LL1	Longlines	-
beam_oth	Other beam trawls (not BT1 or BT2)	-
Pots	Pots	-
OTH	Any gear type	-

Issues relevant for the advice

Discrepancies in stock size at the start of the advice year sometimes arise from differing assumptions made in the single-stock and mixed-fisheries projections for the intermediate year. In the current context, the single-stock forecast for North Sea cod assumes that catches during 2020 will be constrained by the TAC, whereas the mixed-fisheries forecasts assume *status quo* fishing mortality across all stocks. This leads to a substantial overshoot of the TAC in the intermediate year and, thus, a lower SSB at the start of 2021.

Norway lobster fisheries are managed on the basis of one TAC for the whole North Sea, while ICES advises on the basis of FUs. For example, catches of Norway lobster in FU 7 have long been much lower than advised, while catches in FU 6 have been significantly higher than advised since 2012. The mixed-fisheries analysis is based on the ICES catch advice for the individual FUs. As a consequence, model assumptions of fisheries behaviour differ if managed by FU rather than by management unit, and this influences the outcomes of the scenarios.

The present analysis includes only nine demersal fish stocks and ten Norway lobster stocks. Other species are caught in these fisheries and could influence fishing activity. Further stocks may be included in the future.

Who is fishing

Around 6600 vessels from nine nations operate in the Greater North Sea, with the largest numbers coming from UK, Norway, Denmark, the Netherlands, and France. Total landings peaked in the early 1970s and have since declined. The proportion caught by each country of the total annual landings has varied over time (Figure 7). Since 2003, total fishing effort has declined (Figure 8). Profitability of many of the commercial fleets has increased in recent years due to the improved status of many fish stocks, reduced fleet sizes, lower fuel prices, and more efficient fishing gears. The following country paragraphs highlight features of the fleets and fisheries of each country but are not exhaustive descriptions.

Belgium

The Belgian fishing fleet is composed of 65 active vessels, primarily beam trawlers both above and below 24 m in length. Few vessels are smaller than 12 m. Most of the catch is demersal species; sole is the dominant species in value, and plaice the dominant species in volume. Other important species include Norway lobster, anglerfish, turbot, shrimp, lemon sole, Common cuttlefish, squid, rays, and cod.

Denmark

The Danish fleet in 2019 had 717 vessels operating in the Greater North Sea, representing around half of the entire Danish fleet (1560 vessels). The size of the fleet has been generally decreasing over the last decade and in 2010 there were 968 vessels operating in the Greater North Sea (out of a total of 2220 vessels). In the following description a fishing operation is defined as a combination of vessel and gear, therefore any vessel operating more than one gear type will contribute to multiple operations.

- There were around 600 operations by smaller vessels (< 12 m) in 2019 compared to around 800 in 2010. This mainly consists of gillnetting operations supplemented by pot and trap operations for the smaller vessels and demersal operations for the larger vessels within this group.
- For the medium-sized vessels of 12–40 m in length there were around 281 operations in 2019 mainly represented by demersal trawling. This represents a large reduction in operations compared to the 439 recorded in 2010.
- For the largest vessels above 40 m in length the 54 fishing operations in 2019 were split approximately in half between demersal trawlers and pelagic trawlers. This is also a substantial reduction from the level in 2010 where 75 operations were recorded.

The total value of the Danish fishery from the Greater North Sea has been relatively constant over the period 2010 to 2019. The most dominant fleets in value are the demersal trawlers, having around six times the value of gillnetters throughout the period. The value of demersal trawling is currently around 1.5 times the value of pelagic trawling, although this has decreased from the three times higher level in 2010. The most important demersal fisheries target cod, plaice, saithe, northern shrimp, and *Nephrops,* using predominantly bottom trawls with some seine activity. This pattern has been consistent over the last ten years. The most important pelagic fisheries target herring and mackerel for human consumption, and sandeel, sprat, and Norway pout for reduction purposes (i.e. fish meal and oils) which is also consistent for the period.

France

The French fleet in the North Sea is composed of more than 600 vessels. The demersal fisheries operate mainly in the eastern English Channel and southern North Sea and catch a variety of finfish and shellfish species. Up until 2016, the largest fleet segments were gill- and trammelnetters (10–18 m) targeting sole, followed by demersal trawlers (12–24 m) catching a great diversity of fish and cephalopod species, and dredgers catching scallops. Since 2016, the activity of gill- and trammelnetters has decreased substantially, with part of the fleet converting to pot fishery targeting whelks and crustaceans, or stopping their activity altogether because of difficulty in catching sole in the northeastern part of Division 7.d and the southern part of Division 4.c. Smaller boats operate different gears throughout the year and target different species assemblages. There is also a fleet of six large demersal trawlers (>40 m) that target saithe in the northern North Sea and to the west of Scotland. The pelagic fishery is prosecuted by three active vessels catching herring, mackerel, and horse-mackerel.

Germany

The German North Sea fishing fleet comprises more than 200 vessels. Small beam trawlers of 12–24 m length constitute the largest fleet component (around 175 vessels in 2019) and almost exclusively target brown shrimp in the southern North Sea. In addition, some medium- and large-sized beam trawlers (eight vessels, 24–40 m length; three vessels > 40 m length) target sole and plaice, and farm and harvest mussels. Several otter trawlers (ca. nine vessels, 18–24 m length) target Norway lobster and plaice in the North Sea. Medium-sized demersal trawlers (14 vessels, 24–40 m length) mainly target saithe in the northern North Sea, but also catch plaice, cod, hake, and haddock. A restructuring took place in this latter fleet segment with the building of two new trawlers and decommissioning of some older vessels. Large pelagic trawlers (five vessels > 40 m length in 2019) operate in the North Sea pelagic and industrial fisheries that primarily target herring, but also catch horse mackerel, mackerel, sprat, and sandeel.

Overall, a reduction in the number of vessels was recorded for the German North Sea fishing fleet during the last ten years. Especially the number of smaller beam trawlers (12–18 m length, 35 fewer vessels or −25%) and demersal otter trawlers (18–24 m length, 14 fewer vessels or −50%) decreased. The number of large pelagic trawlers stayed stable with five vessels for the last ten years.

Netherlands

The Dutch fleet in the Greater North Sea consists of about 500 vessels. The main demersal fleet is the beam-trawl fleet (275 vessels, of which 85 are > 24 m and 190 are < 24 m) that operates in the southern and central North Sea, targeting sole (dominant in value) and plaice (dominant in volume) as well as other flatfish species. Until the recent EU-wide ban on pulse-trawling most of the > 24 m beam trawlers have used pulse trawls. Most of the smaller beam trawlers ("Eurocutters") seasonally target shrimp or flatfish. Pelagic freezer trawlers (seven vessels, > 60 m) target pelagic species, mainly herring, mackerel, and horse mackerel.

Norway

The Norwegian North Sea fleet is composed of about 1500 vessels. Approximately 94% of these catch demersal species, including fish, crustaceans, and elasmobranchs, while 33% catch pelagic species, including herring, blue whiting, mackerel, and sprat (i.e. 27% catch both pelagic and demersal species). This contrasts with the respective 78% and 54% fractions observed ten years ago (2009), and is mostly driven by a sharp increase in small vessels (< 11 m) catching demersal species only. Sandeel (by weight) makes up a significant part of the Norwegian fishery in the ecoregion. Over 75% of the fleet are small vessels (< 11 m; up from about 60% over ten years, corresponding to an increase of +445 vessels in this segment) that operate near the Norwegian coast and mostly use traps, pots, shrimp trawls and gillnets, catching mackerel, shrimp, crabs, Norway lobster , cleaner wrasses, and several other fish species. Medium-sized vessels (11–24 m) mainly target Norway lobster and crabs using pots and traps; shrimp using trawls; mackerel, horse mackerel, and sprat with purse seines; and cod, saithe, and other demersal fish using gillnets or trawls. The number of vessels in this segment has dropped by over 35% over the last ten years. Larger vessels represent about 15% of the fleet (6% 24–40 m; 9% > 40 m) and target mostly pelagic fish, such as mackerel, Norway pout, and herring, as well as saithe for reduction purposes and consumption. Ten years ago, larger vessels accounted for over 20% of the fleet (9% 24–40 m; 13% > 40m), which factors in both the increase of the number of small vessels and a slight decrease in the number of vessels > 24 m (−13%). The largest vessels among them (>40 m) are mostly pelagic trawlers and purse seiners that operate offshore and account for more than 80% of the total landings (up from 75% in ten years; +40% in absolute landing tonnage).

Sweden

The Swedish fleet in the Greater North Sea comprises more than 400 vessels. Most vessels operate in Skagerrak and Kattegat, but around 25 of the vessels also fish in the North Sea. In total around 130 vessels are involved in demersal trawl fisheries, catching several species in the Kattegat and Skagerrak; mainly Norway lobster, northern shrimp, cod, witch, flounder, and saithe. Around 15 of the demersal vessels also fish in the North Sea where they mainly target cod, saithe, haddock, and northern shrimp. The fleets using mainly passive gears consists of around 270 vessels, of which most are using pots to target Norway lobster, lobster, and edible crab, but also gillnets and lines targeting both demersal and pelagic species. The Swedish passive gear fisheries are almost exclusively located in the Skagerrak and Kattegat. The pelagic fleet fishing with active gears consists of just over ten vessels that mainly target herring and sprat in the Skagerrak and Kattegat. Most of these vessels also fish for mackerel, herring, and sandeel in the North Sea.

The Swedish fleet has decreased by around 20% since 2009. The reduction was similar both for vessels using active gears and passive gears, and for vessels larger than 10 m and those smaller than 10 m. The main reasons for the decline in the fleet are reduced fishing opportunities, poor profitability, scrapping campaigns, and the introduction of annually transferable fishing rights in the demersal fleets in 2017. The fleet reduction is most pronounced in the Skagerrak and Kattegat, whereas the pelagic fleet and the demersal vessels fishing in the North Sea have been rather stable in terms of number of vessels over the last decade.

UK (England)

The English fleet operating in the Greater North Sea ecoregion during 2019 was comprised of 1133 vessels, with a decrease of 33 vessels from 2018. The decrease is part of a longer running trend across many sectors, but most noticeably in the under 10 m fleet, which has reduced by around 200 vessels since 2009.

- The small vessel (< 10 m) sector (around 882 active vessels) operates in the eastern English Channel and coastal North Sea and catches a diversity of fish and shellfish species, with more vessels targeting non-quota shellfish than demersal fish and a small number of vessels (around 25) targeting pelagics.
- The 10–15 m sector has remained relatively stable with a current vessel count of 190 compared to 198 in 2009, although this is a decrease from a maximum of 213 in 2014. Landings from this sector are over 95% non-quota shellfish, with only around 16 vessels targeting finfish.

- The 15–40 m sector is comprised of 70 vessels, falling from 113 in 2009, although this number has been more steady in recent years. This sector predominantly targets cockles and edible crab, with only around 12 vessels targeting demersal finfish.
- There were 12 English vessels over 40 m operating in the North Sea in 2019 and this number has been virtually unchanged since 2009. This largest category of vessel targets finfish, mostly demersal but some pelagic.

UK (Scotland)

The Scottish North Sea fleet comprises around 1000 vessels. More than 120 demersal trawlers (almost all > 10 m) fish for mixed gadoids (cod, haddock, whiting, saithe, and hake,) and for groundfish such as anglerfish and megrim. A fleet of 139 trawlers fish mainly for Norway lobster in the North Sea: 48 of these vessels (< 10 m) operate on the inshore grounds, while 91 (> 10 m) operate over various offshore grounds. Pot or creel fishing is prosecuted by over 650 vessels (mostly < 10 m) targeting lobsters and various crab species on harder inshore grounds. Scallop fishing is carried out by around 80 dredgers (mostly > 10 m). Limited amounts of longlining and gillnetting are also conducted by Scottish vessels. Significant catches of pelagic species are harvested by 18 large vessels, primarily using pelagic trawls.

The Faroe Islands also fish in the Greater North Sea, but ICES does not have information on this fleet.

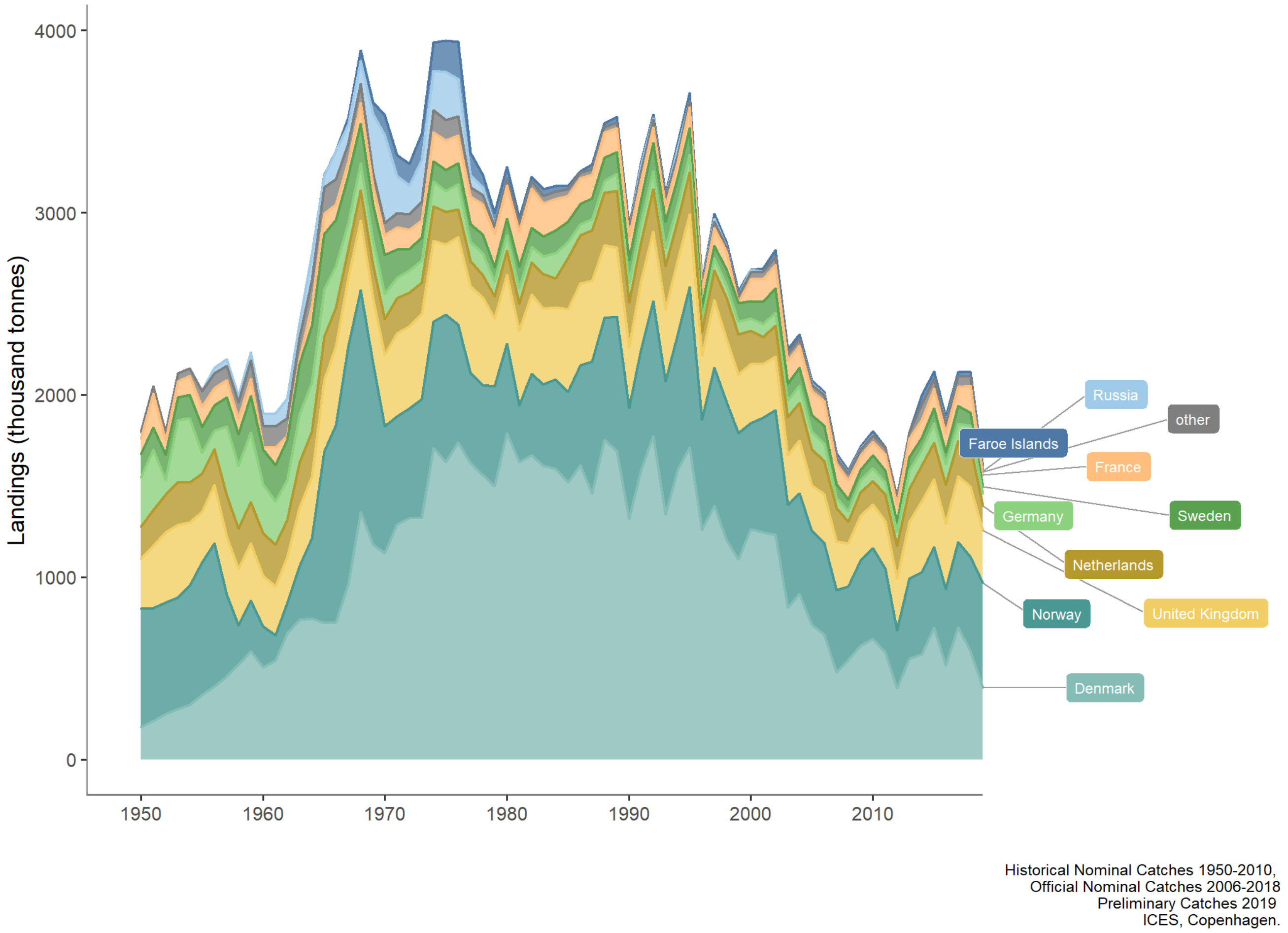


Figure 7 Landings (thousand tonnes) from the Greater North Sea in 1950–2019, by country. The nine countries having the highest landings are displayed separately and the remaining countries are aggregated and displayed as “other”.

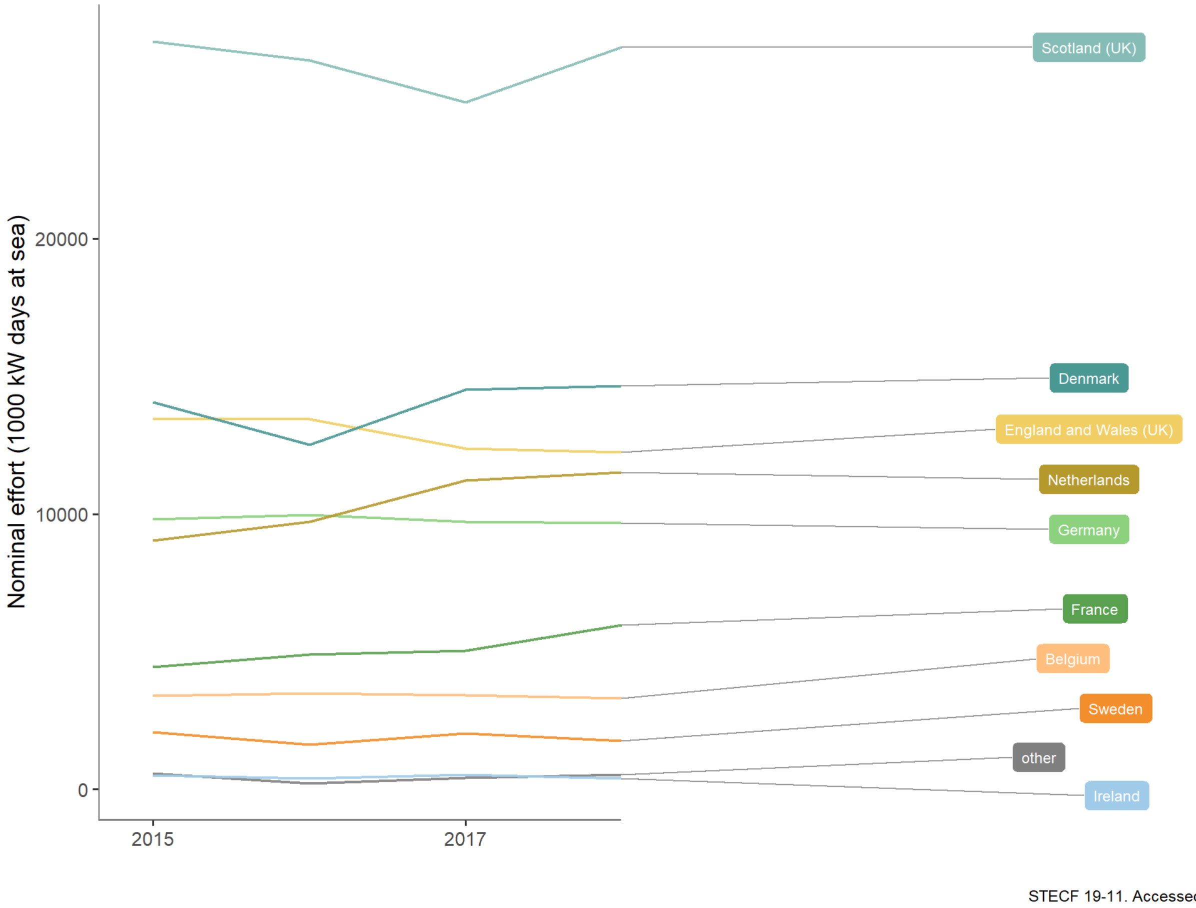


Figure 8 Greater North Sea fishing effort (thousand kW days at sea) in 2015–2018, by EU nation. Confidential values are reported by Belgium, Denmark, Ireland, Lithuania, Netherlands, Poland, Portugal, and France.

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 have only been collected consistently in the most recent years.

Landings

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

Total landings from the Greater North Sea varied between 2 and 3 million tonnes during the 1950s, then rose to between 3 and 4 million tonnes from the late 1960s to the mid-1990s (Figure 7). High catches of both pelagic species (mackerel and herring) and demersal species (cod and haddock) accounted for the increase in total landings in the late 1960s (Figures 10 and 11). The landings shown in figure 10 only include those species for which ICES gives advice. There are a number of stocks for which ICES does not give advice where landings may be substantial (e.g. Scallop, edible crab, brown shrimp, European lobster, blue mussel). Total landings declined after 1995 to a low of 1.4 million tonnes in 2012. This decline is attributed to overfishing and decreased productivity of important stocks such as cod and herring, but also to the successful reduction of fishing mortality to more sustainable levels after 2000.

Since 2003, the pelagic fisheries using pelagic trawl and purse seines have accounted for the largest proportion of the total landings, followed by the demersal and benthic fisheries (Figure 11). Overall landings increased slightly from 2011 after a rise in herring landings and again, most recently (in 2015), from increased catches of anchovy, sardine, and hake.

Recreational fisheries in the North Sea target a wide range of species, but few of these fisheries are monitored or evaluated. Recreational catches of seabass and salmon (including freshwater for the latter) are significant and are included in ICES assessment of these species. In contrast, the recreational fisheries of elasmobranchs is not widely monitored; however, the recreational harvest of these species (mainly dogfish and several species of skates and rays) appears to be negligible.

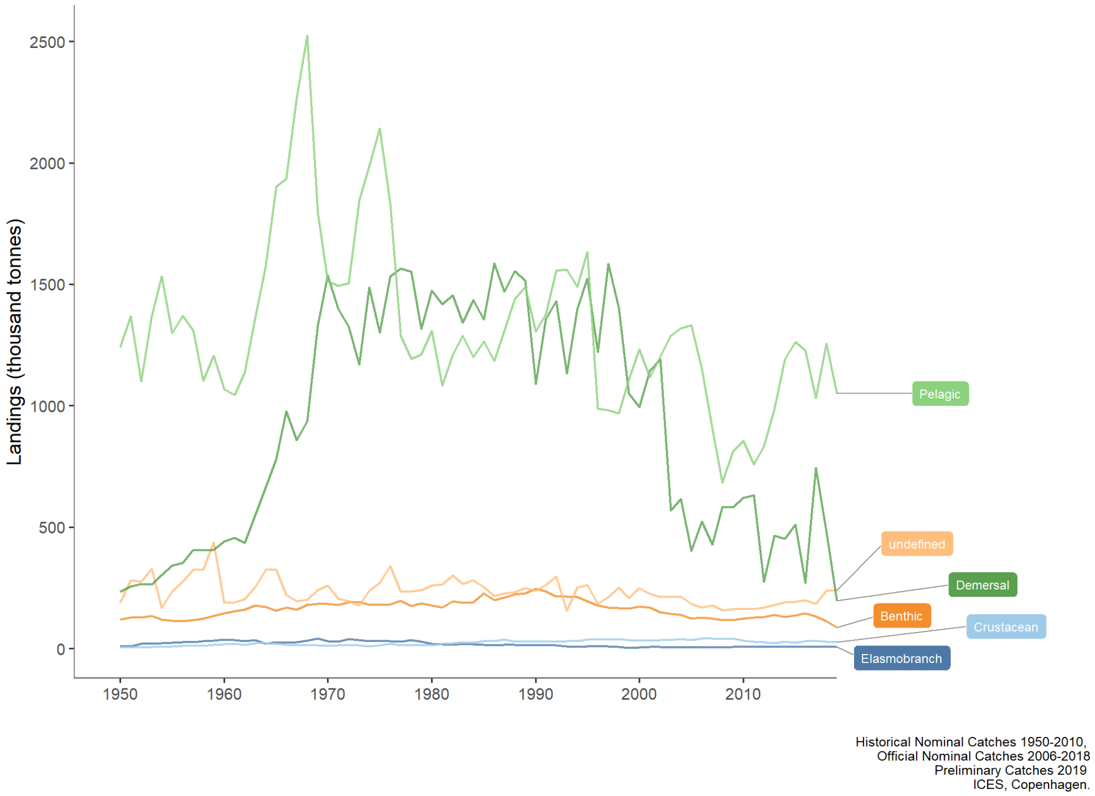


Figure 9 Landings (thousand tonnes) from the Greater North Sea in 1950–2019, by fish category. Table 1 in the Annex details which species belong to each fish category.

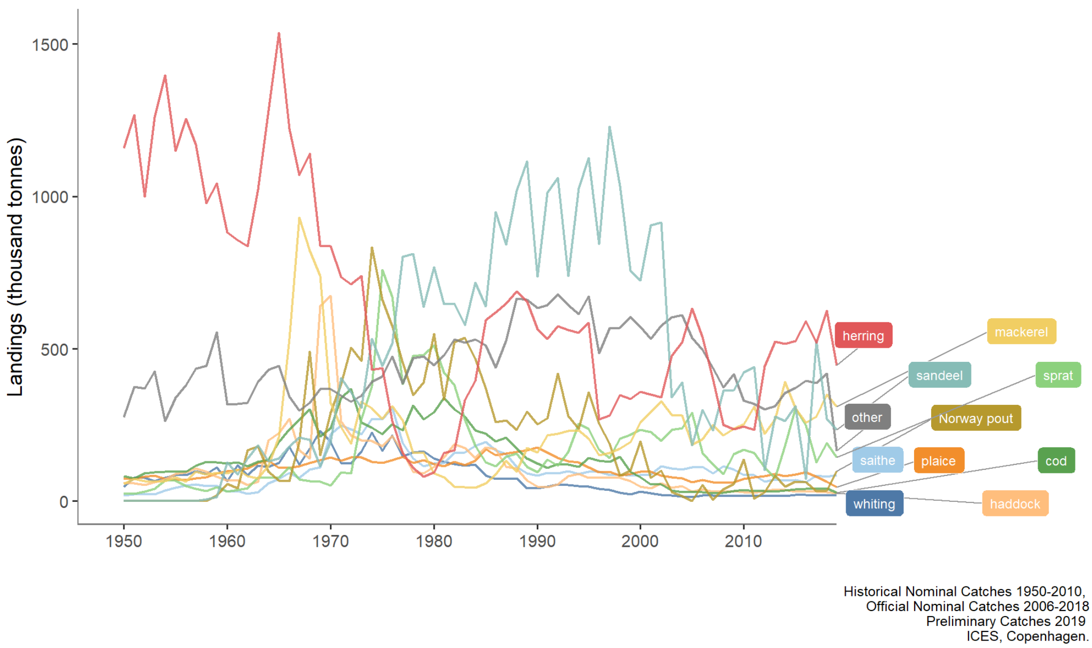


Figure 10 Landings (thousand tonnes) from the Greater North Sea in 1950–2019, by species. The ten species having the highest landings are displayed separately; the remaining species are aggregated and labelled as "other".

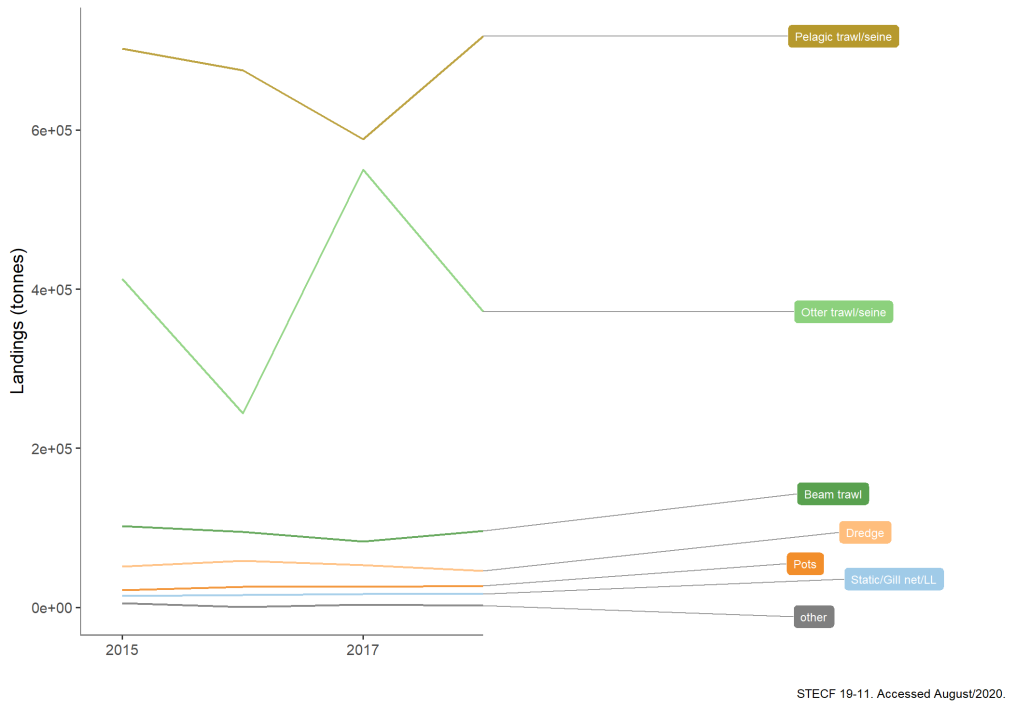


Figure 11 Commercial landings (tonnes) from the Greater North Sea in 2015–2018, by gear type. Confidential values are reported by Belgium, Denmark, Ireland, Lithuania, Netherlands, Poland, Portugal and France.

Discards

Discard data have been collected for some North Sea fisheries since the mid-1970s. Since 2000, discard data from North Sea commercial fisheries have been collected from various observer programmes implemented under the EU Data Collection Framework (DCF). However, complete discard data are only available from 2012 onwards. In 2015–2019, discard rates have remained relatively stable. Discard rates of pelagic species were close to zero (Figure 12). Discard estimates for several species of elasmobranch are highly uncertain due to low encounter probabilities, so not shown here.

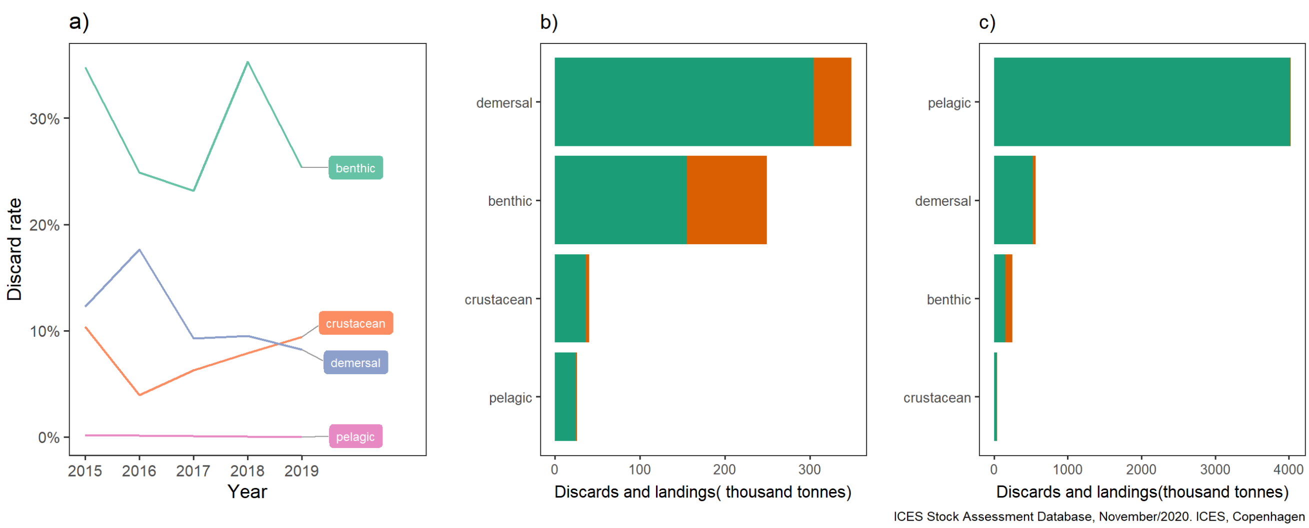


Figure 12 Left panel (a): Discard rates in 2015–2019 by fish category, shown as percentages (%) of the total annual catch in that category. Middle panel (b): Landings (green) and discards (orange) in 2019 by fish category (in thousand tonnes) only of those stocks with recorded discards. Right panel (c): Landings (green) and discards (orange) in 2019 by fish category

(in thousand tonnes) of all stocks. (Note that not all stock catches are disaggregated between landings and discards). Elasmobranch data are highly uncertain and therefore not presented here.[†]

Description of the fisheries

Fishery resources in the Greater North Sea ecoregion are harvested using a variety of fishing gears.

Otter trawl and beam trawls are the main gears used in the region's demersal fisheries, and pelagic trawls and seines are the primary gears used in the pelagic fisheries.

Demersal fishing effort has declined since 2003, while pelagic trawl and seine effort, after a decline, has increased again in recent years (Figure 13).

The spatial distribution of fishing effort by gear type is depicted in Figure 14. The maps show the distribution of effort by vessels >12 m having vessel monitoring systems (VMS). Fishing effort by vessels < 12 m may be significant, especially in inshore areas. However, these vessels are not required to have VMS and ICES does not have information on the spatial distribution of their effort; they are therefore not included in Figure 14.

Some coastal waters in the North Sea ecoregion have fisheries targeting resident immature eels or migrating spawners. In addition, there are also fisheries targeting resident or migrating eel in some transitional waters.

Bottom otter trawl and seine fisheries

Otter trawls are the most common gear types in the Greater North Sea and are used intensively in most parts of the region, including the Skagerrak and the English Channel. Otter trawls typically catch gadoids, other groundfish, plaice, and Norway lobster; however, the species composition of the catch depends on the area and depth fished and the gear design, including codend mesh size. The mixed nature of most of the bottom fisheries and the spatial and temporal heterogeneity of target species challenge the simultaneous achievement of individual stock maximum sustainable yield (MSY) objectives, as well as the limitation of unwanted catches.

In the northern North Sea and the Skagerrak, otter trawls operate primarily with mesh sizes greater than 100 mm and target haddock, cod, whiting, anglerfish, megrim, and plaice, with economically important bycatches of Norway lobster and some flatfish species. Some vessels target saithe in deeper waters in the north of the region. Otter trawlers using smaller mesh otter trawls (70–100 mm) primarily target Norway lobster in soft mud areas. The proportion of Norway lobster landings from mesh sizes greater than 100 mm has recently been increasing.

In the southern North Sea and the eastern English Channel, the otter trawl fleet operates with mesh sizes less than 100 mm, catching a varied mix of fish and shellfish species (including cephalopods) and, in muddy areas, Norway lobster .

Bottom seine fisheries operate mainly in the Skagerrak, central North Sea, and in the eastern English Channel, with limited effort in the northern North Sea. Mesh sizes and targeted species are similar to the otter trawl fisheries in these areas.

Beam-trawl fisheries

Beam-trawl fisheries operate in the shallow parts of the southern and central North Sea, with particularly intense activity off the southeast coast of England. The most important species for beam trawlers are sole and plaice in terms of value and volume, respectively, and other flatfish species (e.g. turbot and brill). Because a relative small codend mesh size (80 mm) is used in beam trawls targeting flatfish, significant quantities of fish below minimum sizes are caught, resulting in high discard rates. Many small beam trawlers (< 24 m) also engage in targeted brown shrimp fishing in the southern North Sea and coastal areas using a 20–25 mm codend mesh size.

Part of the beam-trawl fleet had for several years moved from conventional beam trawls to electric pulse trawl in order to reduce fuel costs, seabed impacts, and unwanted catches. Following a change in European Union legislation (2019/1241)

[†] Version 2: figure and legend updated

these vessels have started to convert back to conventional gears in preparation for the prohibition of electric pulse trawls in areas 4b and 4c as of 1 July 2021.

Static gear fisheries (gillnet and longline)

Gillnet fisheries primarily operate in the shallower areas of the southern North Sea, the eastern English Channel, and in the Skagerrak. Small and medium-sized boats target flatfish and demersal fish, depending on the gear used. Gillnet fisheries conducted in deeper areas also target anglerfish. Discard rates in gillnet fisheries with larger mesh sizes (>100 mm) are generally low; however, bycatch of marine mammals and seabirds occurs. Gillnet fisheries with smaller mesh sizes (90 mm) usually target sole, and may have considerable discard rates of dab.

Longline fisheries operate mostly in the northern North Sea and target saithe, cod, haddock, ling, and tusk.

Pelagic trawl and pelagic seine fisheries

Pelagic trawl and seine fisheries operate throughout most parts of the North Sea, except in the eastern portion of the central North Sea. The small-meshed (< 32 mm codend) pelagic trawl fishery is prosecuted mainly by vessels >40 m and targets sandeel, Norway pout, sprat, and blue whiting for reduction purposes. The pelagic trawl fishery for human consumption is operated by refrigerated seawater trawlers (>40 m) and freezer trawlers (>60 m) and targets herring, mackerel, and horse mackerel. Some blue whiting is taken by these vessels in the northern North Sea.

Dredge fisheries

Significant dredge fisheries for scallops occur in inshore areas along the east coasts of Scotland and England and throughout the English Channel. These fisheries primarily occur on sand and gravel substrates and are affected by exclusion zones that protect sensitive habitats in some areas. Dredges are also used to harvest blue mussels in the nearshore southern and eastern North Sea.

Pot fisheries

Static gear pot fisheries, mainly for edible crab, lobster, and whelk operate in the inshore areas of several countries bordering the North Sea. Most of the vessels are small (< 10 m) however removals by larger (> 15 m) vessels can be substantial.

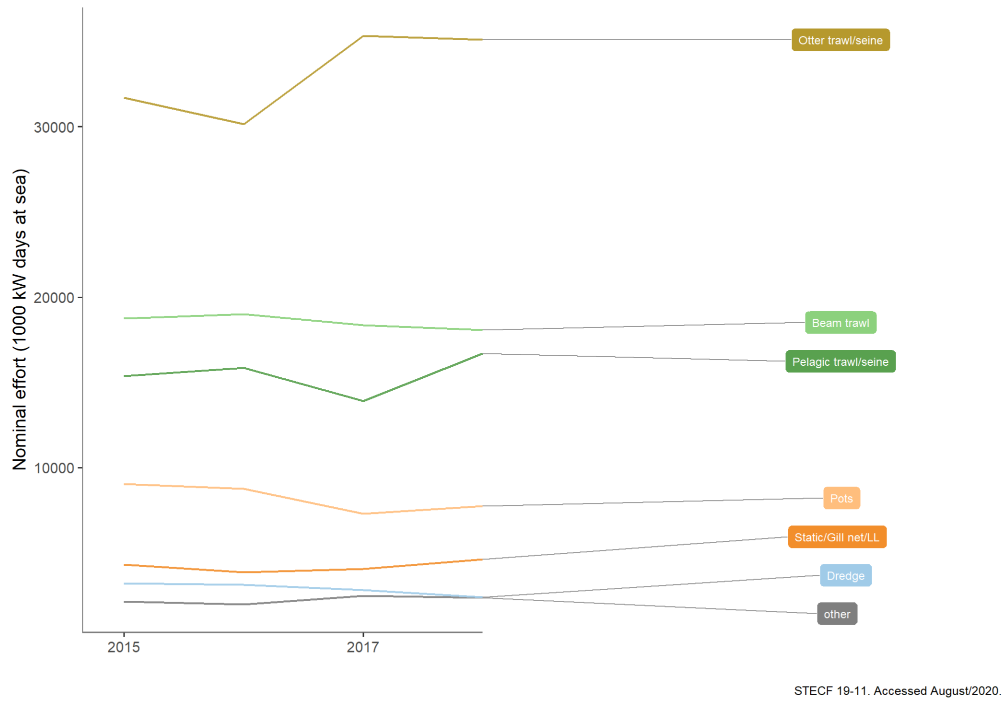


Figure 13 Greater North Sea fishing effort (thousand kW hours at sea) in 2014–2018, by gear type (LL = longlines). Confidential values are reported by Belgium, Denmark, Ireland, Lithuania, Netherlands, Poland, Portugal and France.

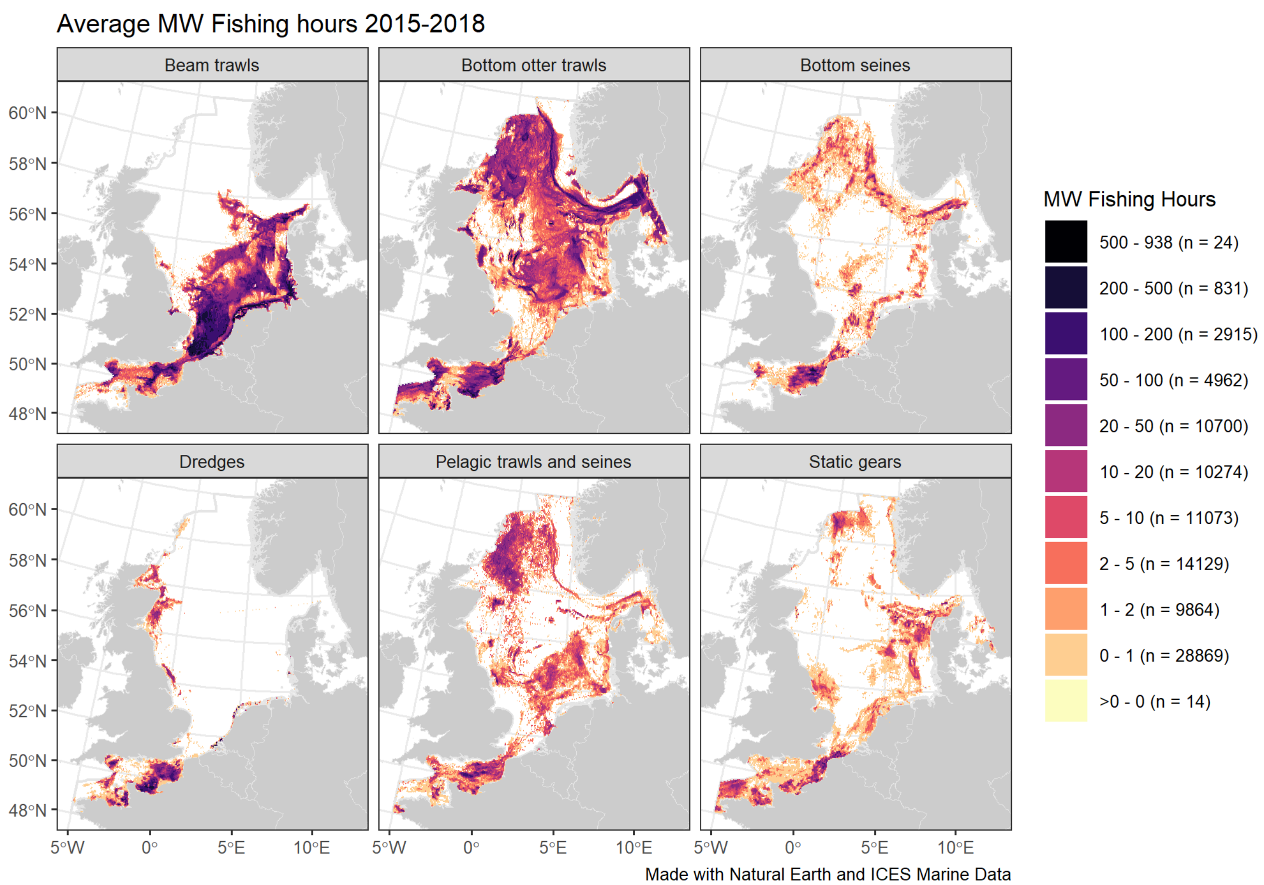


Figure 14 Spatial distribution of average annual fishing effort (MW fishing hours) in the Greater North Sea during 2015–2018, by gear type. Fishing effort data are only shown for vessels >12 m having vessel monitoring systems (VMS).

Fisheries management

Fisheries management in the Greater North Sea is conducted partly under the EU Common Fisheries Policy (CFP) and partly under Norway legislation. Within EU waters, management is conducted in accordance with the CFP and catching opportunities for stocks under EU competency are agreed during meetings of the Council of Ministers. Under the CFP's regionalization policy, proposals on certain issues (for example discard plans) are made by the North Sea Regional Fisheries Group (Scheveningen Group). National authorities manage activities in coastal waters (i.e. within 12 nautical miles) and activities on stocks under national competency (e.g. most shellfish stocks). In Norwegian waters, management of fishing activities in both offshore and inshore waters is conducted in accordance with Norwegian fisheries policy. For North Sea stocks shared between the EU and Norway (cod, haddock, whiting, saithe, herring, plaice, northern shrimp, and sprat), the EU–Norway agreements are based on an annual negotiation process agreeing on catch opportunities and the sharing of these. For more widely distributed stocks that occur in the North Sea (for example mackerel), management is discussed in coastal state consultations. From 2021 the UK will no longer be a member of the EU and new management arrangements will be developed.

The North Atlantic Salmon Conservation Organization (NASCO) has managerial responsibility for the fisheries of salmon. Management of fisheries for large pelagic fish (e.g. tunas, etc.) is undertaken by the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Collective fisheries advice, particularly on the state of stocks and on catch forecasts, is provided by the International Council for the Exploration of the Sea (ICES). Within EU waters, the European Commission's Scientific Technical and Economic Committee for Fisheries (STECF) provides broader advice that also covers technical and economic issues. Furthermore, the North Sea and Pelagic Advisory Councils also provide input to the management process.

Management plans

Several of the demersal stocks in the North Sea are shared between EU and Norway. For shared stocks ICES advice is based on the MSY approach rather than on any management plan. Under the EU CFP, a multi-annual plan (MAP; 2016/0238) has been put in place for the North Sea (EU, 2018). This seeks to implement the MSY policy adopted under the CFP, following best scientific advice. This is done whilst having due regard to the fact that many species are caught together, and that some of the species caught by the fisheries are not targeted but bycatches. Implementing the principles has meant: that target species are identified under the plans (species not listed as target are implicitly considered as bycatches); that TACs are set on target species within a range about F_{MSY}, but the upper part of the range can only be used under the conditions set out in the MAPs. For stocks not shared with Norway the ICES advice is based on the MAPs. Norway is also developing new fishery management plans for North Sea stocks in its waters.

Status of the fishery resources

Fisheries exploitation and spawning-stock sizes of those North Sea stocks that are assessed by ICES have been evaluated against MSY and precautionary approach (PA) reference points, and the most recent status of these stocks is presented relative to safe biological limits (Figures 15 and 16). Most (28 of 46) of the North Sea stocks that are analytically assessed are exploited at rates at or below F_{MSY}. Mean fishing mortality for crustacean, demersal, and benthic fish stock groups have declining trends since the late 1990s (Figure 18). Mean spawning-stock biomass (SSB) for all groups of stocks is above MSY $B_{trigger}$. Note that though the mean fishing mortality and biomass ratios are in a desirable condition, this does not infer that all stocks are in that condition. However, several North Sea stocks have current fishing mortality rates above F_{MSY} (e.g., cod, whiting, haddock, mackerel, and blue whiting). For stock-specific information, see Table A1 in the Annex.

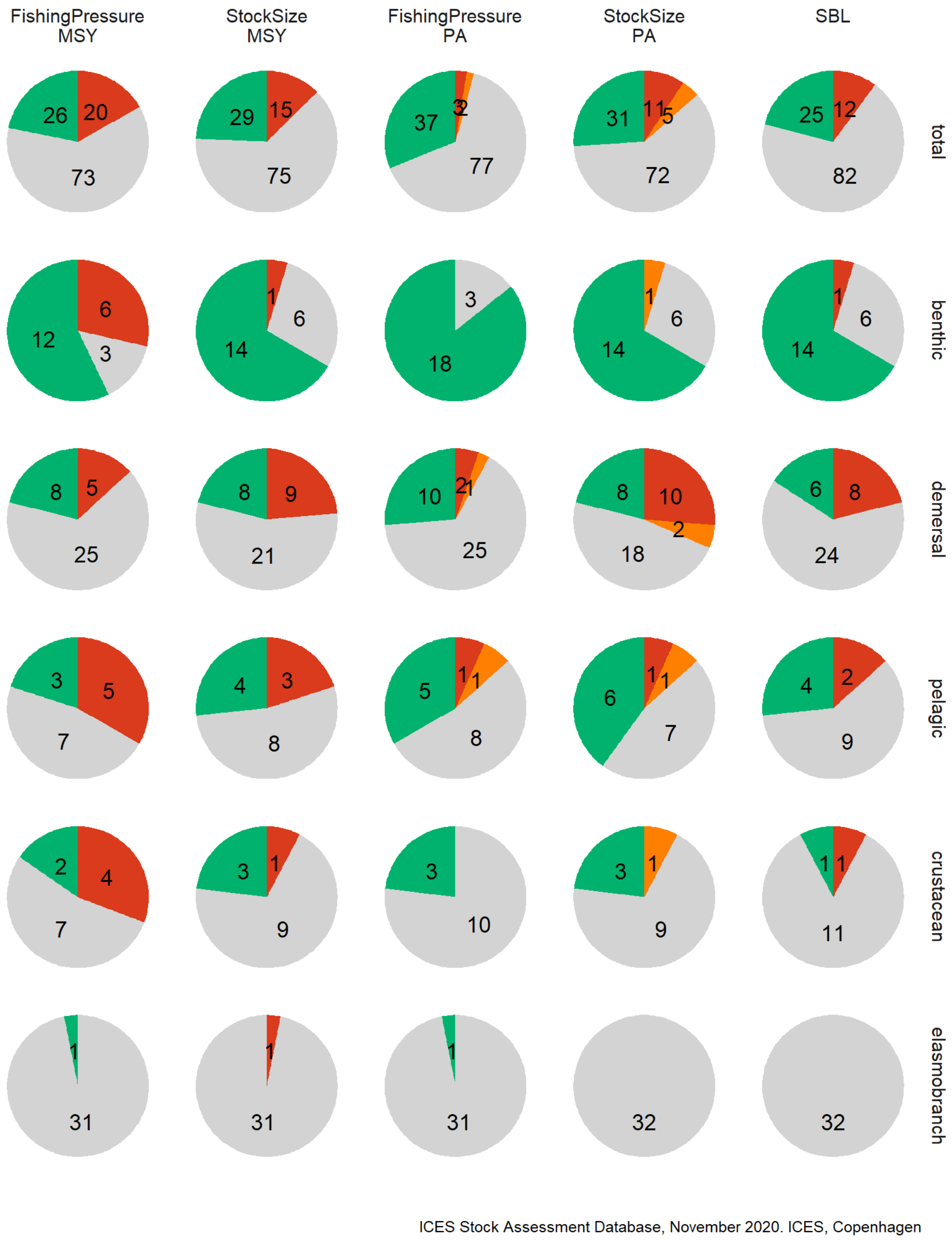
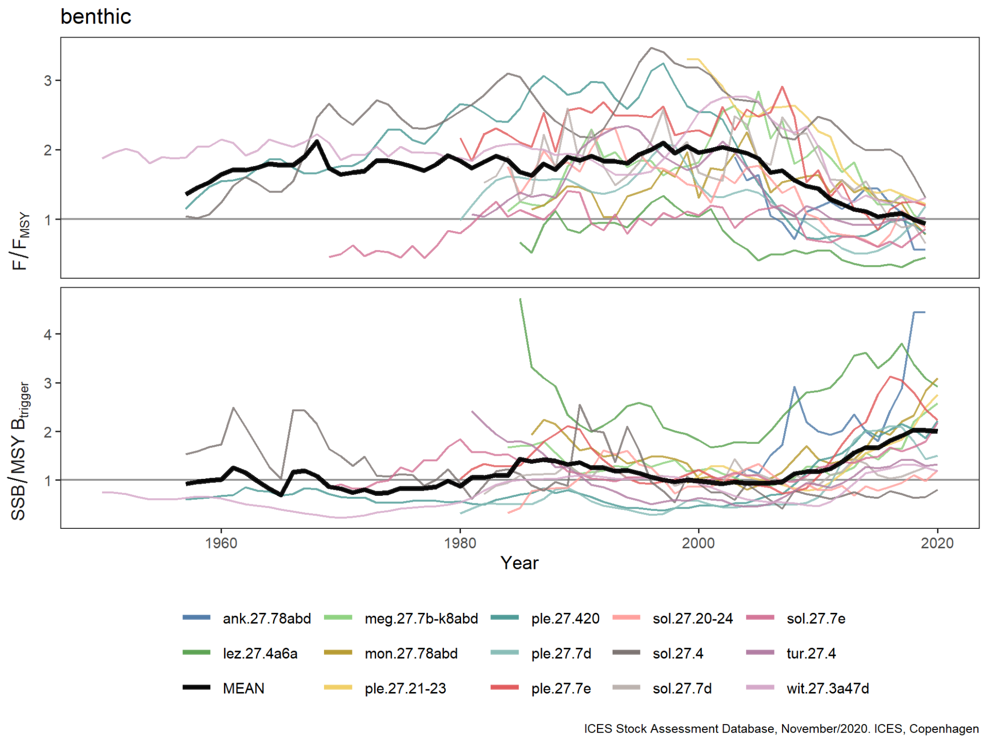
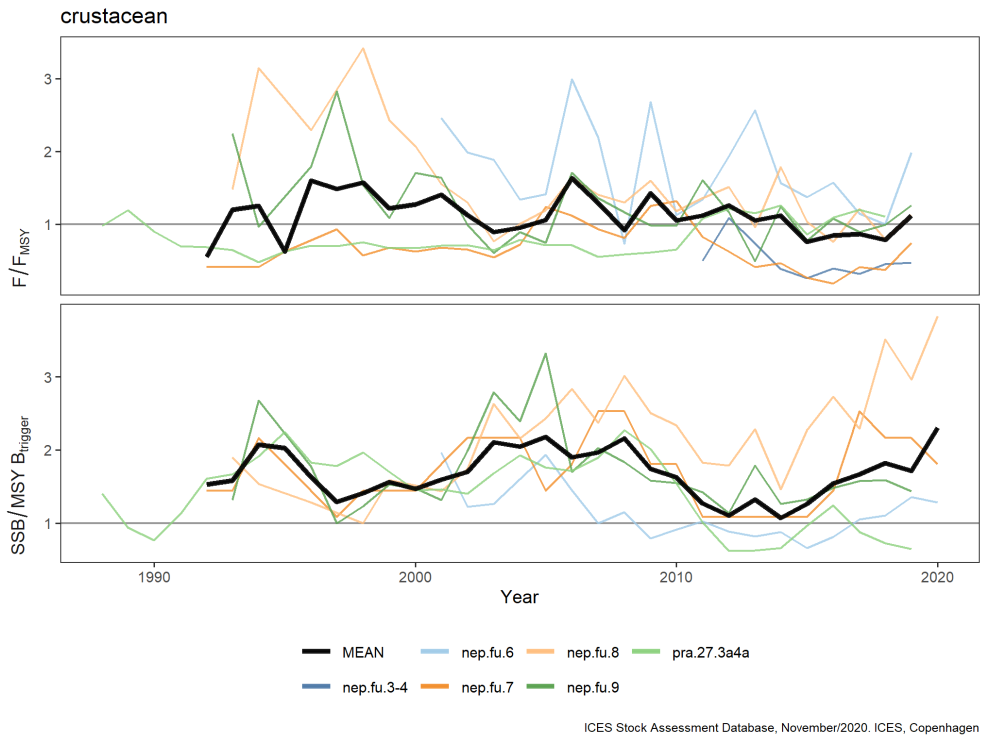


Figure 15 Status summary of Greater North Sea stocks relative to ICES maximum sustainable yield (MSY) approach and precautionary approach (PA). Grey represents unknown reference points. *For the MSY approach*: green represents a stock that is fished at or below F_{MSY} while the stock size is equal to or 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 has a stock size between B_{lim} and B_{pa}; red represents a stock that is fished above F_{lim} or has a stock size lower than B_{lim}. Stocks having a fishing mortality below or at F_{pa} and a stock size at or above B_{pa} are defined as being inside safe biological limits. If this condition is not fulfilled the stock is defined as being outside safe biological limits. For stock-specific information, see Table A1 in the Annex.

Figure 16 Status summary of Greater North Sea stocks in 2020 relative to the EU Marine Strategy Framework Directive (MSFD) good environmental status (GES) assessment criteria of fishing pressure (D3C1) and stock reproductive capacity (D3C2). Green represents the proportion of stocks fished below F_{MSY} or where 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 stock size is lower than MSY $B_{trigger}$ for criteria D3C1 and D3C2. Grey represents the proportion of stocks lacking MSY reference points. For stock-specific information, see Table A1 in the Annex.

Temporal trends (1960 onwards) in F and spawning-stock biomass (SSB) relative to MSY reference points are shown in Figures 17 and 18 for North Sea benthic, crustacean, demersal, and pelagic stocks. For most benthic and demersal stocks, marked improvements in stock status (i.e. having SSB greater than MSY $B_{trigger}$) have occurred since 2000 as F has been reduced. There are no obvious trends in pelagic species. For crustaceans, annual changes in stock status have been more variable and there is a less obvious trend in F reductions.


benthic
F/F$_{MSY}$
SSB/MSY B$_{trigger}$
Year
1960
1980
2000
2020
ank.27.78abd
meg.27.7b-k8abd
ple.27.420
sol.27.20-24
sol.27.7e
lez.27.4a6a
mon.27.78abd
ple.27.7d
sol.27.4
tur.27.4
MEAN
ple.27.21-23
ple.27.7e
sol.27.7d
wit.27.3a47d
ICES Stock Assessment Database, November/2020. ICES, Copenhagen


crustacean
F/F$_{MSY}$
SSB/MSY B$_{trigger}$
Year
1990
2000
2010
2020
MEAN
nep.fu.6
nep.fu.8
pra.27.3a4a
nep.fu.3-4
nep.fu.7
nep.fu.9
ICES Stock Assessment Database, November/2020. ICES, Copenhagen

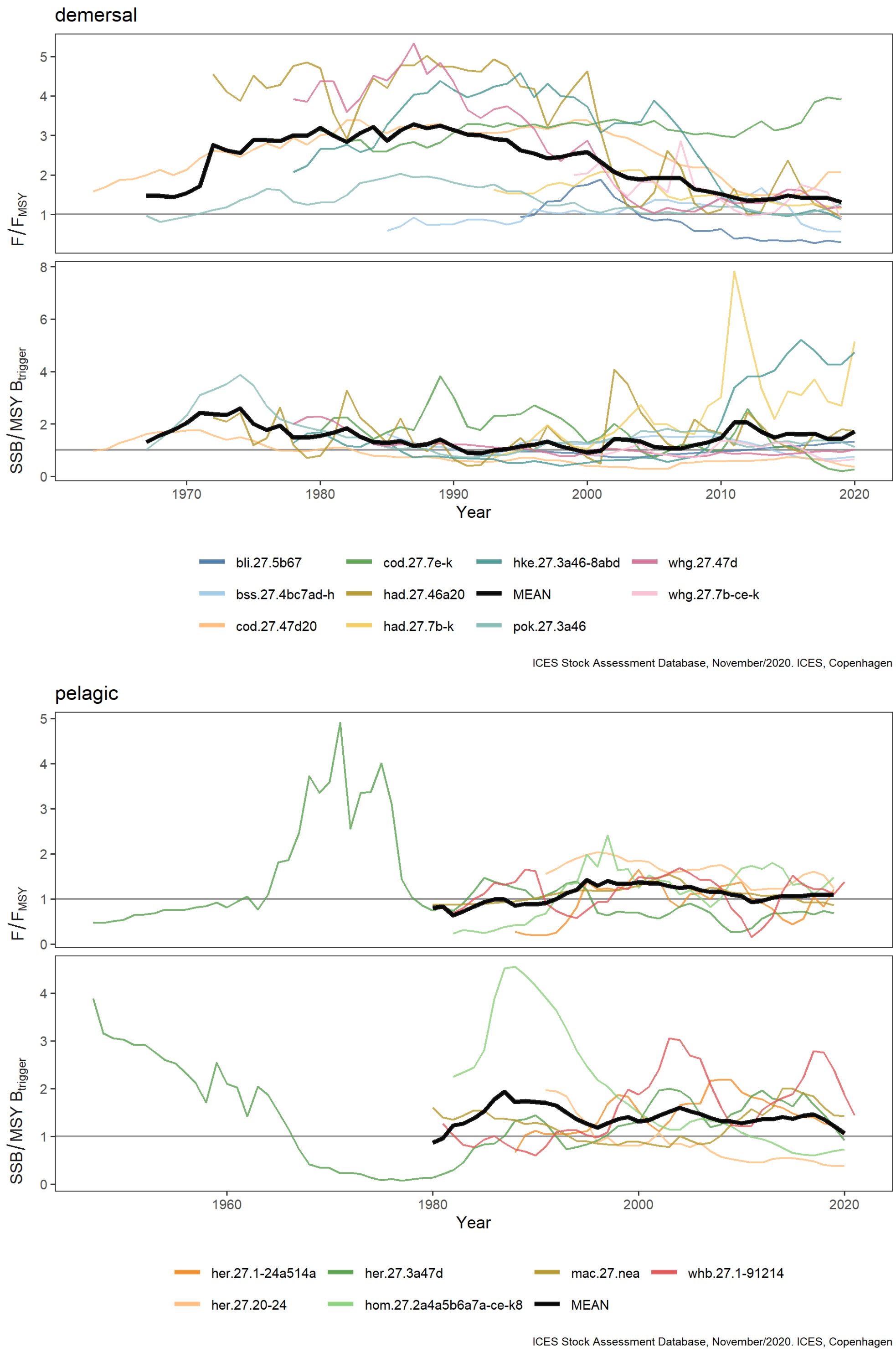
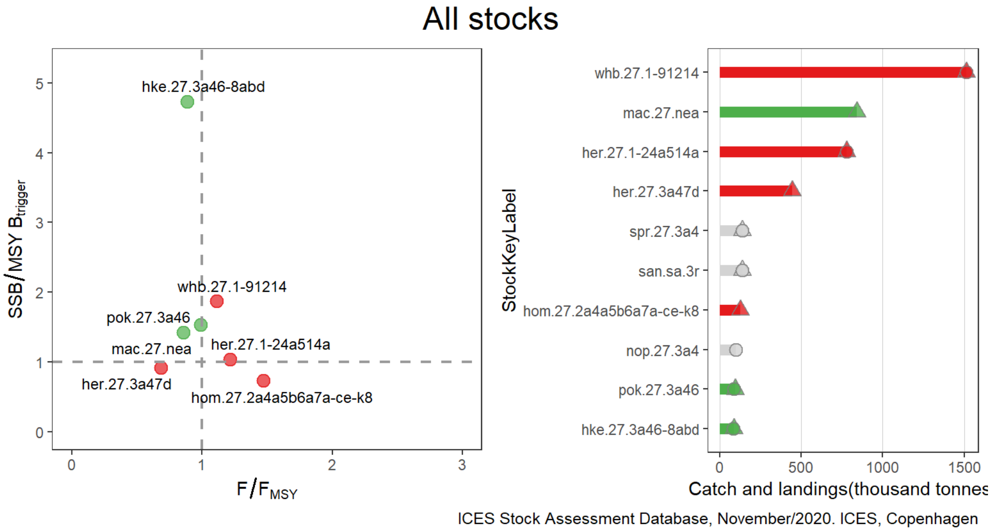
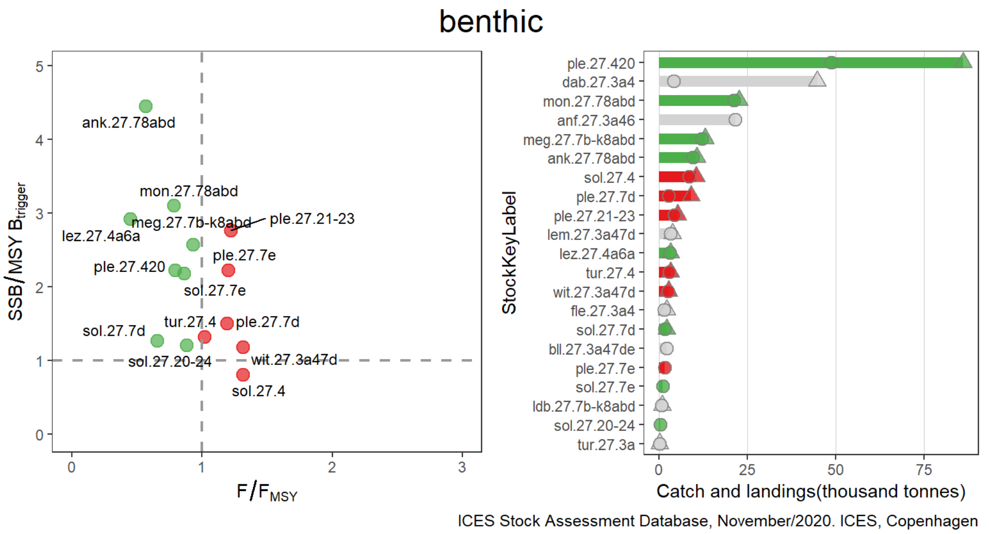
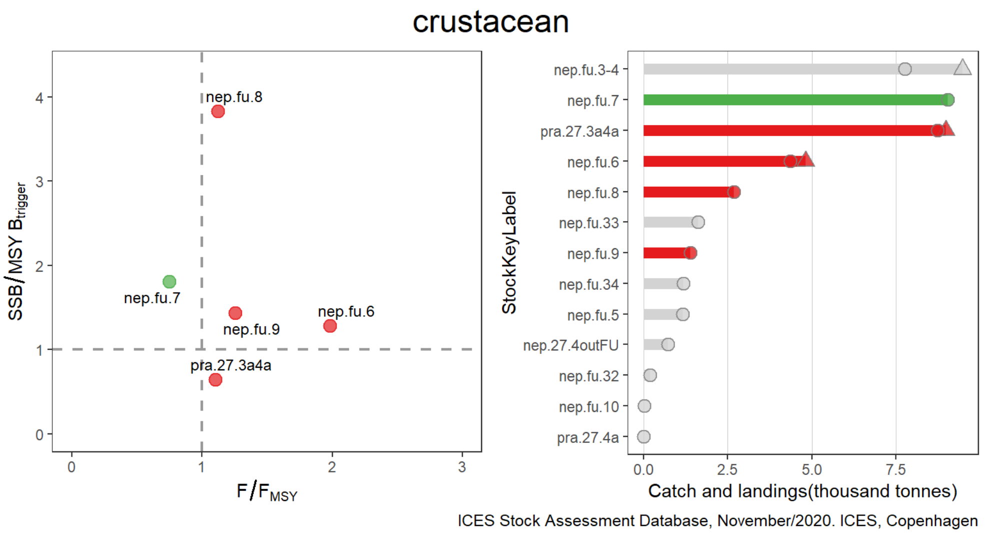


Figure 17 Temporal trends in F/F_{MSY} and SSB/MSY $B_{trigger}$ for North Sea benthic, crustacean, demersal, and pelagic stocks. Only stocks with defined MSY reference points are considered. For full stock names, see Table A1 in the Annex.

The stock status relative to F_{MSY} and MSY $B_{trigger}$ is shown for all stocks and partitioned by stock groups in Figure 18. This shows that the hake stock has the best status among all stocks (around five times MSY $B_{trigger}$ and fished below F_{MSY}). Six stocks (North Sea cod, Celtic Sea cod, Celtic Sea whiting, horse mackerel, herring 20–24, and prawns in divisions 3.a and 4.a) are in the bottom right quadrant having their SSB below MSY $B_{trigger}$ and $F > F_{MSY}$. This indicates that these stocks need to be rebuilt and that fishing mortality remains too high. Note that the Celtic Sea cod and whiting stocks are mainly distributed outside the Greater North Sea ecoregion. The first and third ranked stocks in terms of landings, blue whiting and herring in subareas 1, 2, and 5 and divisions 4.a and 14.a, are located in the top right quadrant, indicating that fishing mortality is higher than F_{MSY} although stock size remains above MSY $B_{trigger}$. Mackerel ranks second and is located in the upper left quadrant, indicating good stock status for both F_{MSY} and MSY $B_{trigger}$. Herring in subarea 4 and divisions 3.a and 7.d ranks fourth, and is located in the lower left quadrant, indicating that fishing mortality is lower than F_{MSY} although stock size is slightly below MSY $B_{trigger}$.







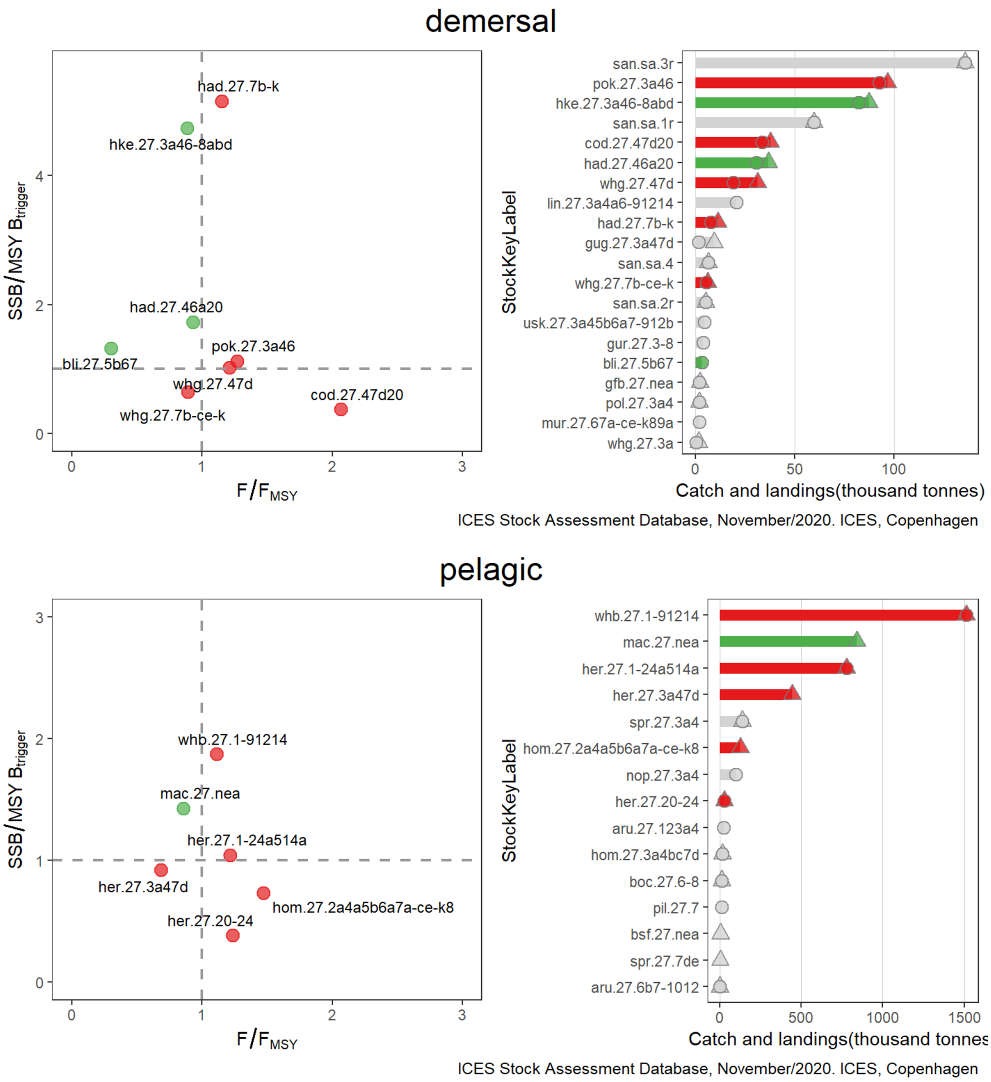


Figure 18 Status of North Sea stocks relative to the joint distribution of exploitation (F/F_{MSY}) and stock size (SSB/ MSY $B_{trigger}$) [left panels, by individual stocks] and catches (triangles) / landings (circles) from these stocks in 2020 [right panels]. The left panels only include stocks for which MSY reference points have been defined (MSY where available). Stocks in green are exploited at or below F_{MSY} while the stock size is also at or above MSY $B_{trigger}$. Stocks in red are either exploited above F_{MSY} or the stock size is below MSY $B_{trigger}$, or both. Stocks in grey have unknown/undefined status in relation to reference points. "All stocks" refers to the ten stocks with highest catch and landings across fisheries guilds in 2020. For full stock names, see Table A1 in the Annex.

Several of the stocks such as North Sea sprat, sandeels, and Norway pout are stocks of short-lived species that experience high natural mortality. The ICES MSY approach for these stocks is aimed at achieving a high probability of having a minimum biomass left to spawn the following year so that the stock is capable of producing MSY. For catch advice, ICES uses a different approach than for longer-lived species and defines a biomass reference point, MSY $B_{escapement}$, which is the biomass that should remain after the fishery has taken place. For some short-lived stocks, an F reference point, F_{cap}, is also used to limit exploitation when biomass is high as large biomasses are often estimated with greater uncertainty.

For some short-lived species, assessments are so sensitive to incoming recruitment that the amount of biomass in excess of the target escapement cannot be reliably estimated until data are available on the incoming year class. In such cases, the ICES catch advice is often provided just prior to, or at the beginning of the fishing season.

A consequence of this approach is that the reference points for short-lived stocks cannot be readily compared and dealt with in the same way as those for longer-lived stocks. In Figure 18, this is reflected in the short-lived species being assigned a "grey" colouration. However, this does not mean that little is known about these stocks, that they are not being managed effectively, or that they are incapable of producing MSY.

European eel cannot be assessed against any PA or MSY reference points. Recruitment of European eel has declined sharply in recent decades due to a range of potential threats.

Mixed fisheries

Many fishing gears catch more than one species, so "technical interactions" between stocks occur when multiple stocks are captured in the same gear during fishing operations. Because these interactions may vary in time and space (e.g. interactions can differ between day and night, occur at different times of the year, and among different areas), it would be ideal if they could be identified at very small temporal and spatial scales. However, as most fisheries data are aggregated based on species, gear, mesh size range, ICES square, and calendar quarter, subtle interactions may be 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 gear, mesh size range, ICES statistical rectangle, and quarter (hereafter referred to as "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 19). In this figure, 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. For example, a high proportion of the catches of lemon sole was taken in fisheries where plaice landings constituted at least 5% of the total landings. Medium quantities of lemon sole were caught in fisheries where cod, haddock, hake, or saithe accounted for at least 5% of the total landings. Low quantities of lemon sole were caught in fisheries where lemon sole constituted 5% or more of the total landings, indicating that there is no (or very limited) targeted lemon sole fishery.

The columns in Figure 19 illustrate the degree of mixing and can be used to identify the main fisheries (target fisheries) and the degree of mixing within these fisheries. Fisheries where plaice (species B) constitute 5% or more of the total landings account for a high share (red cells) of the total landings of dab, lemon sole, plaice, sole, turbot, flounder, brill, haddock, and witch, and a medium share (orange cells) of the landings of whiting, hake, and Norway lobster. This shows that the plaice fishery is a central fishery in the North Sea with a high degree of mixing. The lemon sole column shows that the landings of lemon sole, in fisheries where the species constituted 5% or more of the total landings, were low, and the relative landings of other species in this fisheries were also low. This confirms that there is no or very limited targeted lemon sole fishery.

Technical interactions in North Sea pelagic fisheries are relatively low. For example, in the Danish small-mesh fishery targeting sprat, bycatch of herring has varied between 4% and 16% during the last ten years (2007–2016).

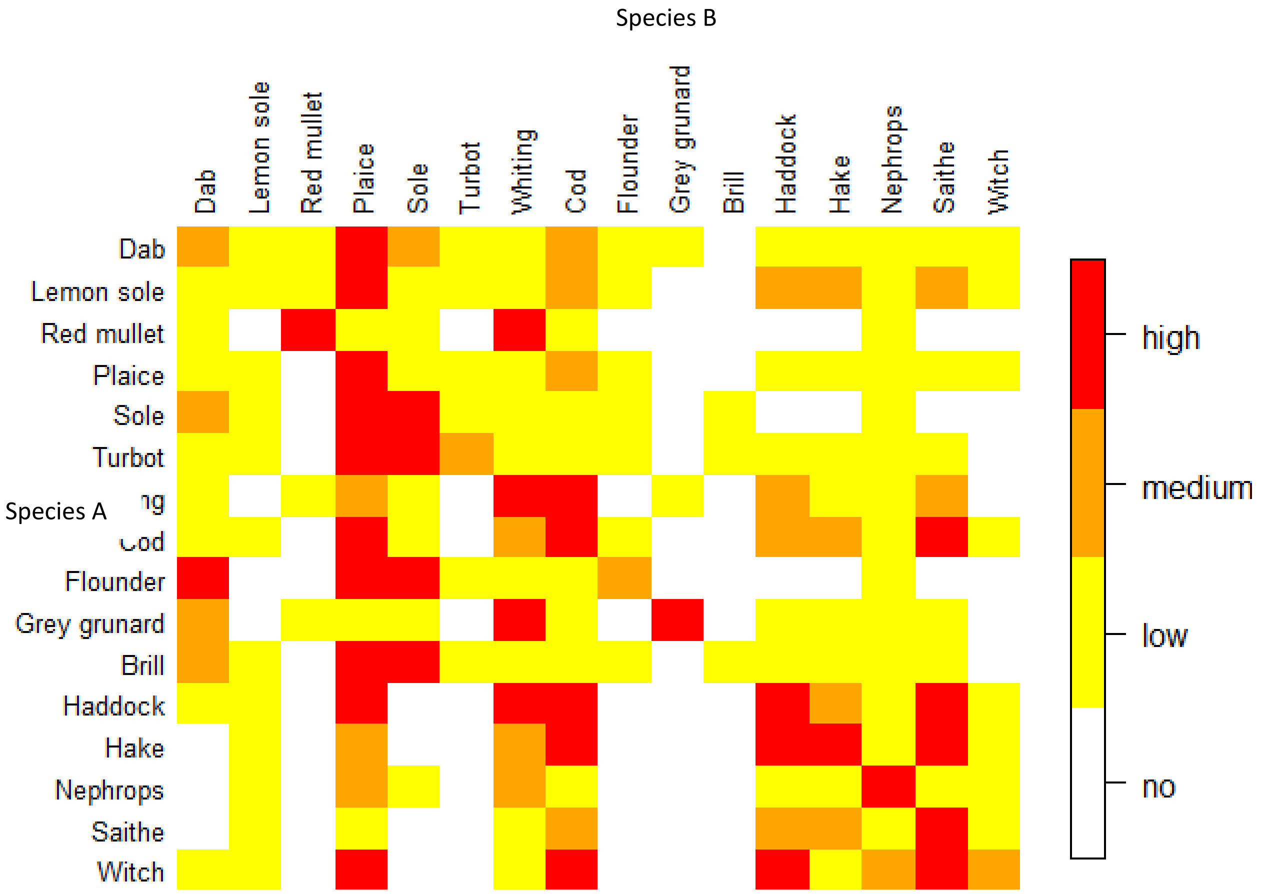


Figure 19 Technical interactions among Greater North Sea demersal stocks. The rows illustrate the fisheries where species A was caught. Red cells indicate the species B (listed as the columns) with which species A are frequently caught. Orange cells indicate medium interactions and yellow cells indicate weak interactions. The column shows the degree of mixing in fisheries where species B accounts for at least 5% of the total landings. A more detailed explanation of the figure is provided in the text.

The species interactions and relative proportions of catches in mixed fisheries are not likely to change greatly between years. Generally, the interactions between species and the selectivity of fisheries change gradually over time.

Multispecies considerations

Fish species are part of the marine food web and interact in various ways, including through predation and competition. Natural mortality is becoming more significant in the North Sea because fishing mortality has been markedly reduced on many stocks. Hence, natural processes are now having a relatively greater effect on the dynamics of these stocks. Predation mortality can occur from other fish, seabirds, and marine mammals. The abundance of larger fish and some mammal species has been increasing in the North Sea, while seabird populations have broadly decreased. Consumption of fish by these predators has been modelled and for several North Sea stocks (cod, haddock, whiting, sprat, sandeel, and herring), and predation mortality is now directly included in the assessments of these stocks. This ensures that temporal changes in natural mortality are explicitly accounted for in these assessments, as well as in the setting of stock-specific reference points.

The modelling results indicate that the yields of many North Sea stocks are strongly affected by the abundance of cod, saithe, and mackerel, which are the main predator fish species. Changes in fishing mortality on these species therefore influences the abundance and yield of other fish stocks. Indirect predation effects are also important. For example, reduced fisheries exploitation on cod increases cod biomass, which not only leads to reductions in SSB and yields of whiting and haddock (direct predation effect) but also to increases in SSB and yield of herring, sandeel, Norway pout, and sprat. The

SSB increases for these prey species are due to the reduction in predation pressure from whiting and haddock, which more than compensates for the increase in direct predation from a larger cod stock (indirect effect).

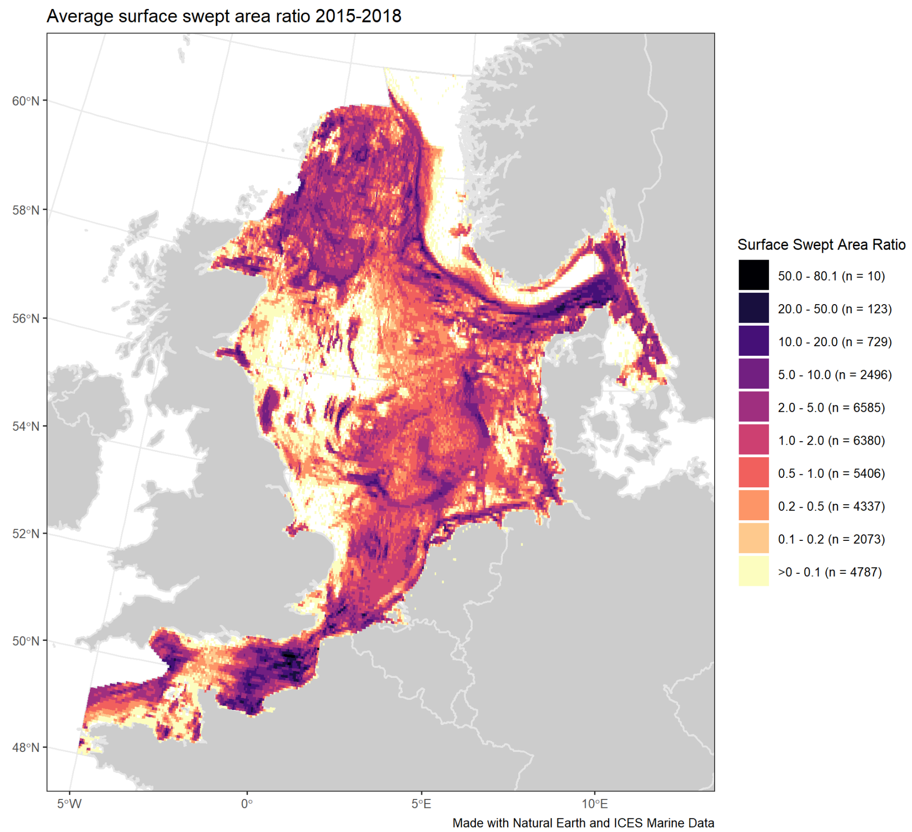
According to model simulations, it is not possible for all stocks to be simultaneously maintained above precautionary single-species biomass reference points. Whiting is the most extreme example of this. Small whiting are subjected to high predation by grey gurnard, and a strong recovery of the cod stock (another significant predator of whiting) increases the probability that the whiting stock will decline below its precautionary biomass reference point.

Any potential target multispecies F_{MSY} depends on management objectives and SSB constraints. No single maximum sustainable yield solution exists in a multispecies context, and policy choices (i.e. trade-offs) have to be made. However, model simulations show that fishing mortalities leading to close-to-maximum average yield (e.g. at least 95% of MSY) and which have a low probability of causing stocks to decline below B_{lim} can be estimated in a multispecies context. The simulations show that in the long term, cod and saithe could be fished at slightly higher Fs to limit predation pressure on their prey, thereby maintaining high SSB and yields of these prey species. In the case of cod, this would also avoid too much loss in cod yield due to cannibalism. The target F_{MSY} depends on managers defining agreed constraints and acceptable risk levels. ICES multispecies simulations of identified scenarios can be used to evaluate the possible consequences of different policy decisions.

Effects of fisheries on the ecosystem

Two different effects of fisheries on the ecosystem are described in this section: (1) Physical disturbance of benthic habitats by bottom trawl fishing gear; and (2) fisheries bycatch of protected, endangered, and threatened species.

The extent, magnitude, and impact of mobile bottom-contacting fishing gear on the seabed and benthic habitats varies geographically across the North Sea (Figure 20). These maps are calculated in terms of a swept-area ratio. Swept area is calculated as hours fished × average fishing speed × gear width. Values for each of these factors were derived from VMS data and other sources. The swept-area ratio is calculated for all 0.05 × 0.05 degree grid cells in the North Sea and is the sum of the swept area divided by the area of each grid cell. The resultant values indicate the theoretical number of times the entire grid cell area would have been swept if effort was evenly distributed within each cell. The swept-area ratio is calculated separately for surface and subsurface contact. Different gear types interact with the seabed in different ways and thus exert different levels of physical disturbance, in terms of the substrate areas affected and the penetration depth. Surface abrasion is defined as the damage to seabed surface features; subsurface abrasion as the penetration and/or disturbance of the substrate beneath the seabed surface. For further information on these effects, see the Greater North Sea ecosystem overview.



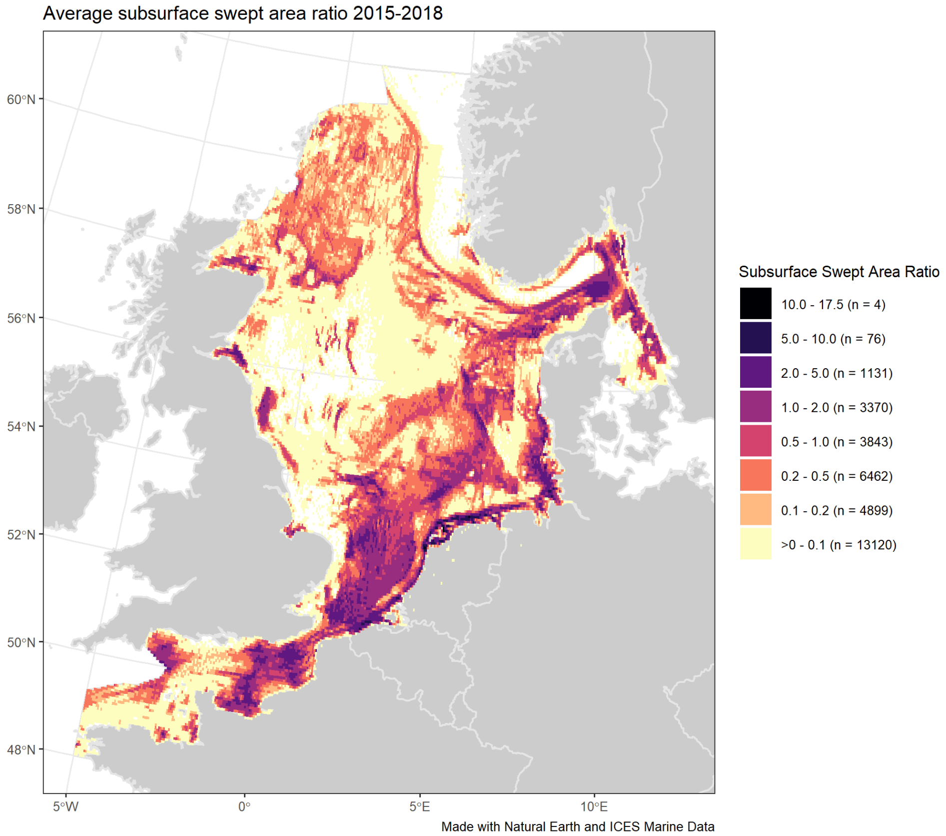


Figure 20 Average annual surface (top) and subsurface (bottom) disturbance by mobile bottom-contacting fishing gear (bottom otter trawls, bottom seines, dredges, beam trawls) in the Greater North Sea during 2015–2018, expressed as average swept-area ratios (SAR).

Some fisheries have the potential to take protected, endangered, or threatened species (i.e., seabirds and marine mammals) as non-targeted bycatch. Recording of the catch of these species has been undertaken in a few North Sea fisheries, where there is perceived particular risk of such bycatch. A recent EU-funded project (fishPi project, 2016) analysed risk from various gears to seabirds and marine mammals and determined that observations were most needed in fisheries using set gillnets, trammelnets, driftnets, and bottom trawls.

Based on patchy observer information with an unknown amount of bias, ICES has advised that bycatch of common dolphins in the western English Channel (the far southwestern part of the Greater North Sea) may be unsustainable in population terms, while the bycatch of harbour porpoise in the Greater North Sea in nets is the ASCOBANS 1% precautionary environmental limit.

High bycatch rate was recorded for grey seals in pelagic trawls in the ecoregion (Division 27.4.b) in 2018 (0.36 specimens per monitored days-at-sea).

Eight species of elasmobranchs that occur in the Greater North Sea ecoregion are listed on OSPAR's list of threatened and declining species. Some of these are rare (e.g. basking shark, angel shark) and seldom caught in fisheries. Other species (e.g. spotted ray, thornback ray) are harvested in some targeted fisheries. Most often, elasmobranchs are taken as incidental bycatch and then discarded (Figure 7), particularly when there is a zero TAC for a species.

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Annex

Supporting data used in the Greater North Sea Fisheries overview is archived at ICES (2020d).

Table A1 Status summary of Greater North Sea stocks in 2020 relative to maximum sustainable yield (MSY) and the ICES precautionary approach (PA). Grey represents unknown reference points. For MSY: green represents a stock that is fished below F_{MSY} or the stock size is above 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 above 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 below B_{lim}. Stocks having a fishing mortality rate at or below 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. SBL = safe biological limits; MSFD = Marine Strategy Framework Directive; D3C1 = MSFD indicator for fishing mortality; D3C2 = MSFD indicator for spawning-stock biomass; GES = good environmental status.

Stock key	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
ank.27.78abd	Black-bellied anglerfish in Subarea 7 and divisions 8.a–b and 8.d	Benthic	3.2	2020	PA	?	?	MSY	✓	?	✓	?
								PA	?	?	?	?
aru.27.123a4	Greater silver smelt in subareas 1, 2, and 4, and in Division 3.a	Pelagic	3.2	2019	PA	?	?	MSY	✓	?	✓	?
								PA	✓	?	✓	?
bli.27.5b67	Blue ling in subareas 6–7 and Division 5.b	Demersal	1	2020	MSY	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
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	?	✗	MSY	?	✗	?	✗
								PA	?	✗	?	✗
bll.27.3a47de	Brill in Subarea 4 and divisions 3.a and 7.d-e	Benthic	3.2	2020	PA	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
bss.27.4bc7ad-h	Seabass in divisions 4.b–c, 7.a, and 7.d-h	Demersal	1.2	2020	MSY	✗	✗	MSY	✓	✗	✓	✗
								PA	✓	o	✓	o
cod.27.47d20	Cod in Subarea 4, Division 7.d, and Subdivision 20	Demersal	1	2020	MSY	✗	✗	MSY	✗	✗	✗	✗
								PA	✗	✗	✗	✗
cod.27.7e-k	Cod in divisions 7.e–k	Demersal	1	2020	MSY	✗	✗	MSY	✗	✗	✗	✗
								PA	✗	✗	✗	✗

Stock key	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
dab.27.3a4	Dab in Subarea 4 and Division 3.a	Benthic	3.2	2019	PA/Stock status only	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
dgs.27.nea	Spurdog in subareas 1–10, 12, and 14	Elasmobranch	1.2	202	MSY/PA	?	?	MSY	✔	✖	✔	✖
								PA	✔	?	✔	?
ele.2737.nea	European eel throughout its natural range	Demersal	3.14	2020	PA	?	?	MSY	?	?	?	?
								PA	?	?	?	?
fle.27.3a4	Flounder in Subarea 4 and Division 3.a	Benthic	3.2	2019	PA/Stock status only	?	?	MSY	✔	?	✔	?
								PA	✔	?	✔	?
gug.27.3a47d	Grey gurnard in Subarea 4 and divisions 7.d and 3.a	Demersal	3.2	2020	No advice	?	?	MSY	✔	?	✔	?
								PA	✔	?	✔	?
had.27.46a20	Haddock in Subarea 4, Division 6.a, and Subdivision 20	Demersal	1	2020	MSY	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
had.27.7b-k	Haddock in divisions 7.b–k	Demersal	1	2020	MSY	✔	✖	MSY	✖	✔	✖	✔
								PA	✔	✔	✔	✔
her.27.1-24a514a	Herring in subareas 1, 2, 5 and divisions 4.a and 14.a, Norwegian spring-spawning herring	Pelagic	1	2020	MP	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
her.27.20-24	Herring in subdivisions 20–24, spring spawners	Pelagic	1.2	2019	MSY	✖	✖	MSY	✖	✖	✖	✖
								PA	o	✖	o	✖
her.27.3a47d	Herring in Subarea 4 and divisions 3.a and 7.d, autumn spawners	Pelagic	1	2019	MSY	✖	✔	MSY	✔	✖	✔	✖
								PA	✔	✔	✔	✔
hke.27.3a46-8abd	Hake in subareas 4, 6, and 7, and divisions 3.a, 8.a–b, and 8.d, Northern stock	Demersal	1	2020	MSY	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
hom.27.2a4a5b6a7a-ce-k8	Horse mackerel in Subarea 8 and divisions 2.a, 4.a, 5.b, 6.a, 7.a–c, and 7.e–k	Pelagic	1	2020	MSY	✖	✖	MSY	✖	✖	✖	✖
								PA	✖	o	✖	o

Stock key	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
hom.27.3a4bc7d	Horse mackerel in divisions 3.a, 4.b–c, and 7.d	Pelagic	3.2	2019	PA	?	✖	MSY	✖	?	✖	?
								PA	?	?	?	?
lem.27.3a47d	Lemon sole in Subarea 4 and divisions 3.a and 7.d	Benthic	3.2	2020	PA	?	?	MSY	✔	?	✔	?
								PA	✔	?	✔	?
lez.27.4a6a	Megrim in divisions 4.a and 6.a	Benthic	1	2020	MSY	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
lin.27.3a4a6-91214	Ling in subareas 6–9, 12, and 14, and in divisions 3.a and 4.a	Demersal	3.2	2019	PA	?	?	MSY	✔	?	✔	?
								PA	✔	?	✔	?
mac.27.nea	Mackerel in subareas 1–8 and 14, and in Division 9.a	Pelagic	1	2020	MSY	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
meg.27.7b-k8abd	Megrim in divisions 7.b–k, 8.a–b, and 8.d	Benthic	1	2020	MP	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
mon.27.78abd	White anglerfish in Subarea 7 and divisions 8.a–b and 8.d	Benthic	1	2020	MP	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
nep.fu.3-4	Norway lobster in Division 3.a, Functional units 3 and 4	Crustacean	1	2020	FMSY Ranges	?	?	MSY	✔	?	✔	?
								PA	✔	?	✔	?
nep.fu.6	Norway lobster in Division 4.b, Functional Unit 6	Crustacean	1	2020	FMSY Ranges	?	✖	MSY	✖	✔	✖	✔
								PA	?	✔	?	✔
nep.fu.7	Norway lobster in Division 4.a, Functional Unit 7	Crustacean	1	2020	FMSY Ranges	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
nep.fu.8	Norway lobster in Division 4.b, Functional Unit 8	Crustacean	1	2020	FMSY Ranges	✖	?	MSY	✔	✖	✔	✖
								PA	✔	?	✔	?
nep.fu.9	Norway lobster in Division 4.a, Functional Unit 9	Crustacean	1	2020	FMSY Ranges	✔	✔	MSY	✔	✔	✔	✔
								PA	✔	✔	✔	✔
nop.27.3a4	Norway pout in Subarea 4 and Division 3.a	Pelagic	1	2020	MSY	?	?	MSY	?	?	?	?
								PA	?	✔	?	✔

Stock key	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
ple.27.21-23	Plaice in subdivisions 21–23	Benthic	1	2020	PA	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
ple.27.420	Plaice in Subarea 4 and Subdivision 20	Benthic	1	2020	MSY	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
ple.27.7d	Plaice in Division 7.d	Benthic	1	2019	MSY	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
ple.27.7e	Plaice in Division 7.e	Benthic	3.2	2020	PA	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
pok.27.3a46	Saithe in subareas 4 and 6, and in Division 3.a	Demersal	1	2020	MSY	✓	✗	MSY	✗	✓	✗	✓
								PA	○	✓	○	✓
pra.27.3a4a	Northern shrimp in divisions 3.a and 4.a East	Crustacean	1	2019	MSY	✗	✗	MSY	✗	✗	✗	✗
								PA	○	○	○	○
san.sa.1r	Sandeel in divisions 4.b and 4.c, Sandeel Area 1r	Demersal	1	2020	MSY	✗	✗	MSY	?	✗	?	✗
								PA	?	✗	?	✗
san.sa.2r	Sandeel in divisions 4.b and 4.c, and Subdivision 20, Sandeel Area 2r	Demersal	1.2	2020	MSY	✗	✗	MSY	?	✗	?	✗
								PA	?	✗	?	✗
san.sa.3r	Sandeel in divisions 4.a and 4.b, and Subdivision 20, Sandeel Area 3r	Demersal	1	2020	MSY	✓	?	MSY	?	✓	?	✓
								PA	?	✓	?	✓
san.sa.4	Sandeel in divisions 4.a and 4.b, Sandeel Area 4	Demersal	1	2020	MSY	✗	?	MSY	?	✗	?	✗
								PA	?	○	?	○
sol.27.20-24	Sole in subdivisions 20–24	Benthic	1	2020	MSY	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
sol.27.4	Sole in Subarea 4	Benthic	1	2020	FMSY Ranges	✗	✗	MSY	✗	✗	✗	✗
								PA	✓	○	✓	○
sol.27.7d	Sole in Division 7.d	Benthic	1	2020	MSY	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓

Stock key	Stock description	Fisheries guild	Data category	Assessment year	Advice category	SBL	GES	Reference point	Fishing pressure	Stock size	D3C1	D3C2
sol.27.7e	Sole in Division 7.e	Benthic	1	2020	MSY	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
spr.27.3a4	Sprat in Division 3.a and Subarea 4	Pelagic	1	2020	NA	✓	?	MSY	?	✓	?	✓
								PA	?	✓	?	✓
tur.27.4	Turbot in Subarea 4	Benthic	1	2020	PA	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
usk.27.3a45b6a7-912b	Tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a, and 12.b	Demersal	3.2	2019	PA	✓	✓	MSY	✓	✓	✓	✓
								PA	✓	✓	✓	✓
whb.27.1-91214	Blue whiting in subareas 1–9, 12, and 14	Pelagic	1	2020	MP	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
whg.27.47d	Whiting in Subarea 4 and Division 7.d	Demersal	1	2020	MSY	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓
whg.27.7b-ce-k	Whiting in divisions 7.b–c and 7.e–k	Demersal	1	2020	MSY	✓	✗	MSY	✓	✗	✓	✗
								PA	✓	✗	✓	✗
wit.27.3a47d	Witch in Subarea 4 and divisions 3.a and 7.d	Benthic	1	2020	MSY	✓	✗	MSY	✗	✓	✗	✓
								PA	✓	✓	✓	✓

Annex (continued)

Table A2 List of those stocks in the Greater North Seas ecoregion in 2018 that do not have a full set of reference points.

Stock code	Stock name	Fish category	Data category	Year of assessment	Reference point
alf.27.nea	Alfonsinos in subareas 1–10, 12, and 14	Demersal	5.2	2020	PA
anf.27.3a46	Anglerfish in subareas 4 and, and Division 3.a	Benthic	3.2	2020	PA
aru.27.6b7-1012	Greater silver smelt in subareas 7–10 and 12, and Division 6.b	Pelagic	3.2	2019	PA
boc.27.6-8	Boarfish in subareas 6–8	Pelagic	3.2	2019	PA
bsf.27.nea	Black scabbardfish in subareas 1, 2, 4–8, 10, and 14, and divisions 3.a, 9.a, and 12.b	Pelagic	3.2	2020	PA
bsk.27.nea	Basking shark in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
cod.27.21	Cod in Subdivision 21	Demersal	3.2	2019	PA
cyo.27.nea	Portuguese dogfish in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
gag.27.nea	Tope in subareas 1–10, 12, and 14	Elasmobranch	5.2	2019	PA
gfb.27.nea	Greater forkbeard in subareas 1–10, 12, and 14	Demersal	3.2	2020	PA
guq.27.nea	Leafscale gulper shark in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
gur.27.3-8	Red gurnard in subareas 3–8	Demersal	6.2	2019	PA
ldb.27.7b-k8abd	Four-spot megrim in divisions 7.b–k, 8.a–b, and 8.d	Benthic	5.9	2020	PA/Stock status only
mur.27.3a47d	Striped red mullet in Subarea 4 and divisions 7.d and 3.a	Demersal	3.2	2019	PA
mur.27.67a-ce-k89a	Striped red mullet in subareas 6 and 8, and divisions 7.a–c, 7.e–k, and 9.a	Demersal	5.2	2020	PA
nep.fu.10	Norway lobster in Division 4.a, Functional Unit 10	Crustacean	4.14	2020	PA

Stock code	Stock name	Fish category	Data category	Year of assessment	Reference point
nep.fu.32	Norway lobster in Division 4.a, Functional Unit 32	Crustacean	4.14	2020	PA
nep.fu.33	Norway lobster in Division 4.b, Functional Unit 33	Crustacean	4.14	2020	PA
nep.fu.34	Norway lobster in Division 4.b, Functional Unit 34	Crustacean	4.14	2020	PA
nep.fu.5	Norway lobster in divisions 4.b and 4.c, Functional Unit 5	Crustacean	4.14	2020	PA
ory.27.nea	Orange roughy in subareas 1–10, 12, and 14	Demersal	6.3	2020	PA
pol.27.3a4	Pollack in Subarea 4 and Division 3.a	Demersal	5.2	2018	PA/Stock status only
pol.27.67	Pollack in subareas 6–7	Demersal	4.12	2020	PA
por.27.nea	Porbeagle in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
pra.27.4a	Northern shrimp in Division 4.a West	Crustacean	6.3	2019	PA
raj.27.3a47d	Rays and skates in Subarea 4 and in divisions 3.a and 7.d	Elasmobranch	6.9	2020	PA
raj.27.67a-ce-h	Rays and skates in Subarea 6 and divisions 7.a–c and 7.e–h	Elasmobranch	6.9	2020	No advice
rja.27.nea	White skate in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
rjb.27.3a4	Common skate complex and flapper skate in Subarea 4 and Division 3.a	Elasmobranch	6.3	2019	PA/Stock status only
rjb.27.67a-ce-k	Common skate complex and flapper skate in Subarea 6 and in divisions 7.a–c and 7.e–k	Elasmobranch	6.3	2020	PA/Stock status only
rjc.27.3a47d	Thornback ray in Subarea 4 and in divisions 3.a and 7.d	Elasmobranch	3.2	2019	PA
rjc.27.7e	Thornback ray in Division 7.e	Elasmobranch	5.2	2020	PA
rje.27.7de	Small-eyed ray in divisions 7.d and 7.e	Elasmobranch	5.2	2020	PA
rjf.27.67	Shagreen ray in subareas 6–7	Elasmobranch	5.2	2020	PA

Stock code	Stock name	Fish category	Data category	Year of assessment	Reference point
rjh.27.4a6	Blonde ray in Subarea 6 and Division 4.a	Elasmobranch	5.2	2019	PA
rjh.27.4c7d	Blonde ray in divisions 4.c and 7.d	Elasmobranch	3.2	2019	PA
rjh.27.7e	Blonde ray in Division 7.e	Elasmobranch	5.2	2020	PA
rji.27.67	Sandy ray in subareas 6–7	Elasmobranch	5.2	2020	PA
rjm.27.3a47d	Spotted ray in Subarea 4 and in divisions 3.a and 7.d	Elasmobranch	3.2	2019	PA
rjm.27.7ae-h	Spotted ray in divisions 7.a and 7.e–h	Elasmobranch	3.2	2020	PA
rjn.27.3a4	Cuckoo ray in Subarea 4 and Division 3.a	Elasmobranch	3.2	2019	PA
rjn.27.678abd	Cuckoo ray in subareas 6–7 and in divisions 8.a–b and 8.d	Elasmobranch	3.2	2020	PA
rjr.27.23a4	Starry ray in subareas 2 and 4, and in Division 3.a	Elasmobranch	3.14	2019	PA
rju.27.7de	Undulate ray in divisions 7.d and 7.e	Elasmobranch	3.2	2020	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	Demersal	6.2	2019	PA
rng.27.3a	Roundnose grenadier in Division 3.a	Demersal	3.2	2020	PA
rng.27.5b6712b	Roundnose grenadier in subareas 6–7 and divisions 5.b and 12.b	Demersal	5.2	2020	PA
san.sa.5r	Sandeel in Division 4.a, Sandeel Area 5r	Demersal	5.3	2019	PA
san.sa.6	Sandeel in subdivisions 20–22, Sandeel Area 6	Demersal	5.2	2019	PA
san.sa.7r	Sandeel in Division 4.a, Sandeel Area 7r	Demersal	5.3	2019	PA
sbr.27.6-8	Blackspot seabream in subareas 6–8	Demersal	6.3	2020	PA

Stock code	Stock name	Fish category	Data category	Year of assessment	Reference point
sck.27.nea	Kitefin shark in subareas 1–10, 12, and 14	Elasmobranch	6.3	2019	PA
sdv.27.nea	Smooth-hound in subareas 1–10, 12, and 14	Elasmobranch	3.2	2019	PA
sho.27.67	Black-mouth dogfish in subareas 6 and 7	Elasmobranch	3.9	2019	PA/Stock status only
san.27.6a	Sandeel in Division 6.a	Demersal	6.3	2018	No advice
spr.27.7de	Sprat in divisions 7.d and 7.e	Pelagic	3.2	2020	PA
syc.27.3a47d	Lesser spotted dogfish in Subarea 4 and in divisions 3.a and 7.d	Elasmobranch	3.9	2019	PA
syc.27.67a-ce-j	Lesser spotted dogfish in Subarea 6 and in divisions 7.a–c and 7.e–j	Elasmobranch	3.9	2019	PA
syt.27.67	Greater-spotted dogfish in subareas 6 and 7	Elasmobranch	3.9	2019	No advice
tur.27.3a	Turbot in Division 3.a	Benthic	3.2	2020	PA/Stock status only
whg.27.3a	Whiting in Division 3.a	Demersal	5.2	2020	PA/Stock status only

Table A3 Scientific names of species.

Common name	Scientific name	Common name	Scientific name
Alfonsinos	*Beryx spp.*	Northern shrimp	*Pandalus borealis*
Angel shark	*Squatina squatina*	Norway lobster	*Nephrops norvegicus*
Anglerfishes	*Lophius budegassa, Lophius piscatorius*	Norway pout	*Trisopterus esmarkii*
Basking shark	*Cetorhinus maximus*	Orange roughy	*Hoplostethus atlanticus*
Black-bellied anglerfish	*Lophius budegassa*	Plaice	*Pleuronectes platessa*
Black-mouth dogfish	*Galeus melastomus*	Pollack	*Pollachius pollachius*
Black scabbardfish	*Aphanopus carbo*	Porbeagle	*Lamna nasus*
Blackspot seabream	*Pagellus bogaraveo*	Portuguese dogfish	*Centroscymnus coelolepis*
Blonde ray	*Raja brachyura*	Queen scallop	*Chlamys opercularis*
Blue ling	*Molva dypterygia*	Rays and skates	*Rajidae*
Blue whiting	*Micromesistius poutassouu*	Red gurnard	*Chelidonichthys cuculus*
Boarfish	*Capros aper*	Roughhead grenadier	*Macrourus berglax*
Brill	*Scophthalmus rhombus*	Roughsnout grenadier	*Trachyrincus scabrus*
Cod	*Gadus morhua*	Roundnose grenadier	*Coryphaenoides rupestris*
Common dolphin (Long-finned)	*Delphis delphinus*	Saithe	*Pollachius virens*
Common skate complex	*Dipturus batis-complex,* including flapper skate *Dipturus cf. flossada* and blue skate *Dipturus cf. intermedia*	Sardine	*Sardina pilchardus*
Cuckoo ray	*Leucoraja naevus*	Sandeel	*Ammodytes spp.*
Dab	*Limanda limanda*	Sandy ray	*Leucoraja circularis*
European eel	*Anguilla anguilla*	Seabass	*Dicentrarchus labrax*
Flounder	*Platichthys flesus*	Shagreen ray	*Leucoraja fullonica*
Four-spot megrim	*Lepidorhombus boscii*	Small-eyed ray	*Raja microocellata*
Greater forkbeard	*Phycis blennoides*	Smooth-hound	*Mustelus spp.*
Greater silver smelt	*Argentina silus*	Sole	*Solea solea*
Greater-spotted dogfish	*Skyliorhinus stellaris*	Spotted ray	*Raja montagui*
Grey gurnard	*Eutrigla gurnardus*	Sprat	*Sprattus sprattus*
Haddock	*Melanogrammus aeglefinus*	Spurdog	*Squalus acanthias*
Hake	*Merluccius merluccius*	Starry ray	*Amblyraja radiata*
Harbour porpoise	*Phocoena phocoena*	Striped red mullet	*Mullus surmuletus*
Horse mackerel	*Trachurus trachurus*	Thornback ray	*Raja clavata*
Herring	*Clupea harengus*	Tope	*Galeorhinus galeus*
Kitefin shark	*Dalatias licha*	Turbot	*Scophthalmus maximus*
Leafscale gulper shark	*Centrophorus squamosus*	Tusk	*Brosme brosme*
Lemon sole	*Microstomus kitt*	Undulate ray	*Raja undulata*
Lesser-spotted dogfish	*Scyliorhinus canicula*	White anglerfish	*Lophius piscatorius*
Ling	*Molva molva*	White skate	*Rostroraja alba*
Mackerel	*Scomber scombrus*	Whiting	*Merlangius merlangus*
Megrim	*Lepidorhombus whiffiagonis*	Witch	*Glyptocephalus cynoglossus*
Megrims	*Lepidorhombus spp.*		