

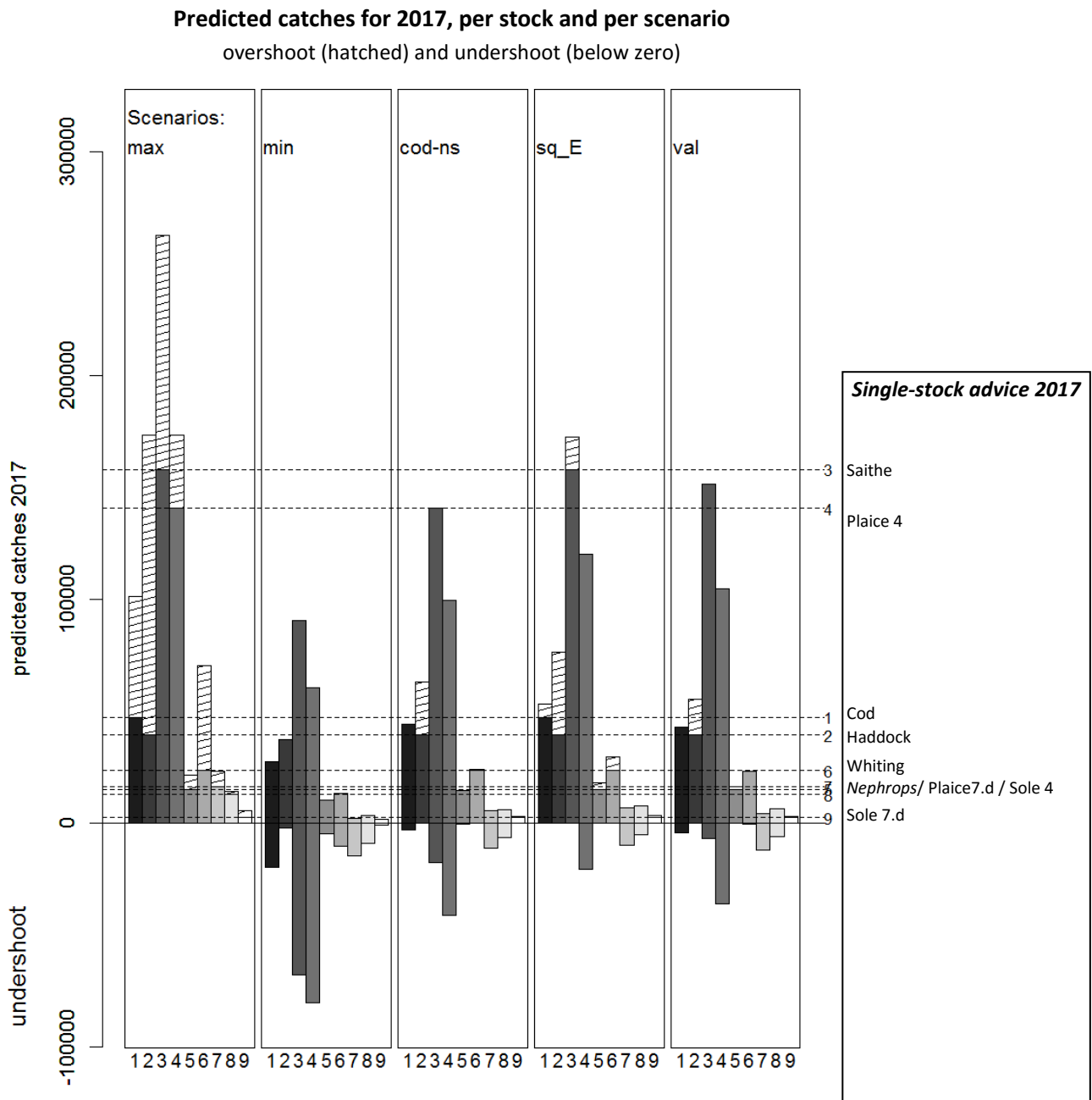
## 6.2 Mixed-fisheries advice for Subarea 4, Division 7.d, and Subdivision 3.a.20 (North Sea, eastern English Channel, Skagerrak)

### ICES Advice

Mixed-fisheries considerations are based on the single-stock assessments, combined with knowledge of the species composition in catches in the North Sea, Skagerrak, and eastern English Channel fisheries. Five example scenarios (described in Table 6.2.1) of fishing opportunities considering mixed fisheries are presented, taking into account the single-stock advice for fisheries catching cod, haddock, whiting, saithe, plaice, sole, and *Nephrops*. In the absence of specific mixed-fisheries management objectives, ICES does not advise on unique mixed-fisheries catch opportunities for the individual stocks.

Mixed-fisheries scenarios are based on central assumptions that fleets' fishing patterns and catchability in 2016 and 2017 are the same as those in 2015 (similar to procedures in single-stock forecasts where growth and selectivity are assumed constant).

Mixed-fisheries projections are presented in terms of catch. The limiting TAC will be the TAC for haddock and, to a lesser extent, cod and eastern English Channel sole, which are the stocks for which the TACs are almost entirely taken when assuming that fishing fleets stop fishing once they reached their first quota (scenario "min" in Figure 6.2.1 and Table 6.2.1).



**Figure 6.2.1** North Sea mixed-fisheries projections. Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the single-stock catch advice for 2017. 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. Details for Division 7.d plaice and sole stocks are shown in Figure 6.2.5.

The mixed-fisheries results shown for *Nephrops* are combined for several functional units (FUs) in plots, but stock status and fishing opportunities differ across FUs.

**Table 6.2.1** Mixed-fisheries scenarios for the North Sea stocks.

	Scenarios
Max	<b>“Maximum”</b> : For each fleet, fishing stops when all stocks have been caught up to the fleet’s stock shares*. This option causes overfishing of the single-stock advice possibilities of most stocks.
Min	<b>“Minimum”</b> : For each fleet, fishing stops when the catch for any one of the stocks meets the fleet’s stock share. This option is the most precautionary option, causing underutilization of the single-stock advice possibilities of other stocks.
Cod	<b>“Cod MSY approach”</b> : All fleets set their effort corresponding to their cod stock share, regardless of other catches. (The differences in the cod catches between this scenario and the single-stock advice are due to slightly different forecast methods used.)
Sq_E	<b>“Status quo effort”</b> : The effort of each fleet is set equal to the effort in the most recently recorded year for which landings and discard data are available (2015).
Val	<b>“Value”</b> : A simple scenario accounting for the economic importance of each stock for each fleet. The effort by fleet is equal to the average of the efforts 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.

\* 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, which has been calculated based on the single-stock advice for 2016 and the observed proportion of the stock landings taken by the fleet in 2015.

### Catch options

Mixed-fisheries advice considers the implications of mixed fisheries operating under single-stock TAC regimes, taking into account the fishing pattern and catchability of the various fleets in 2015. The scenarios therefore do not assume any amount of quota balancing through adaptation of fishing behaviour. Catch options are presented in Table 6.2.2 under the scenarios described in Table 6.2.1, with the resulting biomass at the beginning of 2018 shown in Table 6.2.6 and Figure 6.2.6. Scenarios that result in under- or overutilization are useful in identifying the main points of friction between the fishing opportunities of the various stocks. They indicate in which direction fleets may have to adapt to fully utilize these catch opportunities.

For the second year in a row, cod was not estimated to be the most limiting stock in the “Minimum” scenario. For 2017, assuming a strictly implemented discard ban (corresponding to the “Minimum” scenario), haddock would be the most limiting stock (assuming that the full advised catch is taken), constraining 36 out of 41 fleet segments (corresponding to 91% of the 2015 kW days of effort). Cod and eastern Channel sole would be limiting for fleets, corresponding to 5% and 4% of the 2015 effort, respectively. Conversely, in the “Maximum” scenario with *Nephrops* managed by separate TACs for the individual functional units (FUs), *Nephrops* would be considered the least limiting stocks in many FUs. *Nephrops* in FU 33, FU 5, FU 32, FU 7, and FU Others would be the least limiting stocks for fleets in these FUs, representing 32%, 16%, 10%, 4%, and 17% of the 2015 effort, respectively. Eastern Channel plaice and saithe would be least limiting for fleets, representing 12% and 9% of the 2015 effort, respectively. The most and least limiting species per fleet are shown in Figure 6.2.2.

The ICES single-stock catch advice for demersal stocks in 2017 (ICES, 2016a) is based on either the existing management plans, the ICES maximum sustainable yield (MSY) approach, or the ICES precautionary approach.

Mixed-fisheries catch options can take specific management priorities into account. Scenario results show that it is not possible to achieve all management objectives simultaneously. For instance, if decreasing the fishing mortality for haddock is the major objective; this could mean that the TAC for other species in the mixed fisheries may not be fully utilized. In contrast to single-stock advice there is therefore no single recommendation, but a range of options.

ICES single-stock advice provides TACs expected to meet single-stock  $F_{MSY}$ . To be consistent with these objectives a scenario is necessary that delivers the SSB and/or F objectives of the single-stock advice simultaneously for all stocks considered. This is achieved in the “Minimum” scenario. Additionally, the “Minimum” scenario assumes that fleets would stop fishing when their first stock share is exhausted, regardless of the actual importance of this stock share for the fleet. While this can be considered an unlikely scenario as long as discarding is allowed, this scenario reflects the constraints that result from a strictly implemented discard ban. Fishing effort should be reduced by 50% of its 2015 level to comply with this scenario, consistently with the reductions in fishing mortality advised for haddock, eastern English Channel sole, and cod.

In contrast to the “Minimum” scenario, the “Maximum” scenario demonstrates the upper bound of potential fleet effort and stock catches. However, through assuming that all fleets continue fishing until all their stock shares are

exhausted irrespective of the economic viability of such actions, this is also considered a scenario to be avoided. Its purpose is to illustrate where the imbalance lies. The different fleets have different opportunities and incentives for 2017, depending on their historical catch composition and catchability patterns and on the differences in productivity across the various stocks that they exploit. In 2017 the fleets catching *Nephrops* and eastern English Channel plaice even as bycatch would have to double their effort to achieve their stock shares for these stocks, leading to potentially large overshoots of their target stocks. This is a potentially unrealistic outcome for such fleets; the “Maximum” scenario indicates these fleets are unlikely to fully utilize their stock shares for *Nephrops* and eastern English Channel plaice as these stocks require the highest effort.

Three intermediate scenarios reflect the current management measures, and also the *status quo* option.

The “Cod” scenario reflects the fishing mortality corresponding to the single-stock advice for cod (based on the ICES MSY approach), and the results present fishing opportunities for other stocks in a mixed-fisheries context. Similar scenarios based on the single-stock advice for the other finfish stocks could be provided by ICES, but the “Cod” scenario is included here because cod has traditionally been the most limiting species since the beginning of mixed-fisheries analysis in 2006, though not since 2015.

The *status quo* “SQ\_E” scenario sets the effort of each fleet equal to the effort in the most recently recorded year for which landings and discard data are available (2015). This scenario is a proxy for *status quo* in terms of total effort and effort allocation among métiers.

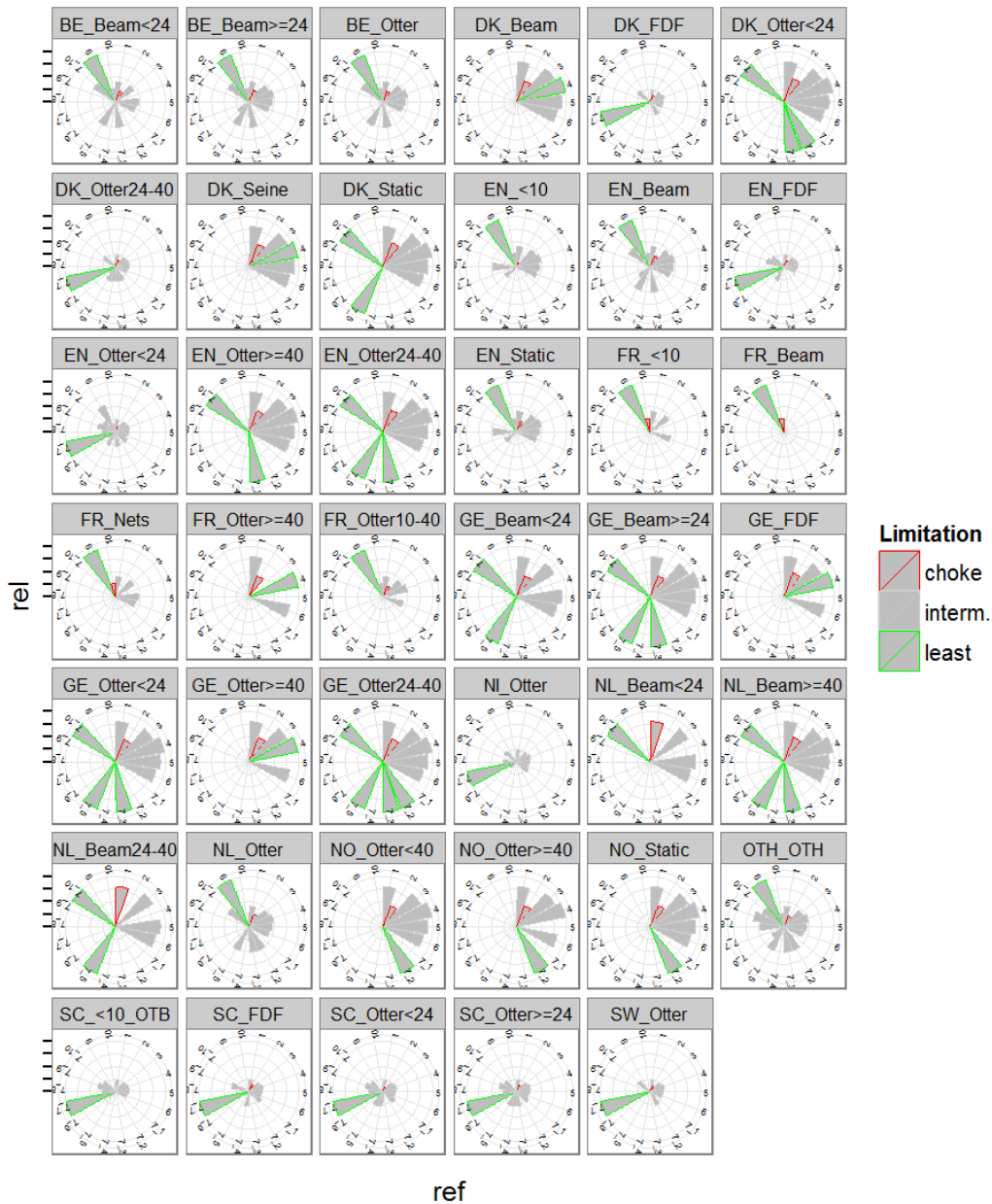
The “Value” scenario is a simple proxy balancing fishing opportunities by stock with their potential market value, in the absence of a formal economic behaviour model. For example, if a fleet needs 100 days of fishing to catch its share of stock A, and 200 days of fishing to catch its share of stock B, and if the value (tonnage × mean price in 2015) of that fleet’s stock shares is 75% from stock A and 25% from stock B, then the resulting effort would be  $(100 \times 0.75) + (200 \times 0.25) = 125$  days. For 2017, this scenario estimates effort levels close to the *status quo*, and historically this scenario has been observed to predict effort levels closer to the realised effort than the “Minimum” and “Maximum” scenarios (Ulrich *et al.*, 2011). In the “Value” scenario, some overshoot of cod, whiting, and sole, and undershoot of plaice and haddock fishing opportunities is predicted.

**Table 6.2.2** Mixed-fisheries advice in the North Sea. Catch per mixed-fisheries scenario 2017, in absolute values.

Stock	Single-stock catch advice (2017) *	Catch per mixed-fisheries scenario (2017)				
		Maximum	Minimum	Cod	<i>Status quo</i> effort	Value
Cod in 4, 7.d, 3.a.20	47359	101418	27555	44297	53409	43203
Haddock in 4, 6.a, 3.a.20	39461	173276	37456	63300	76311	55544
Plaice in 7.d	12805	14428	3743	6278	7693	6747
Plaice in 4	158201	262508	90697	140887	172413	151464
Saithe in 4, 6, 3.a.20	140653	173391	60589	99696	120378	104672
Sole in 7.d	2487	5532	1915	2934	3473	3164
Sole in 4	15251	21551	10620	14786	18020	16321
Whiting in 4, 7.d	23527	70502	13502	23957	29532	23214
<i>Nephrops</i> FU 5	1391	1968	194	474.3	590.7	387
<i>Nephrops</i> FU 6	1143	6700	622.9	1700	2117	1410
<i>Nephrops</i> FU 7	11852	6600	713.6	1543	1922	1199
<i>Nephrops</i> FU 8	2548	7188	688	1713	2134	1425
<i>Nephrops</i> FU 9	1070	2952	285	691.2	860.8	573.9
<i>Nephrops</i> FU 10	40	57.78	5.693	13.92	17.34	11.36
<i>Nephrops</i> FU 32	496	718.4	70.79	173.1	215.6	141.2
<i>Nephrops</i> FU 33	1119 **	1810	178.3	436.1	543.1	355.8
<i>Nephrops</i> FU 34	492	708.3	69.79	170.7	212.5	139.3
<i>Nephrops</i> other in 4	376 **	558.2	55	134.5	167.5	109.7

\* Advised catches no more than the indicated value.

\*\* Advised catches for these stocks are reported as wanted catch rather than total catch.



**Figure 6.2.2** Mixed-fisheries advice in the North Sea. Estimates of effort by fleet needed to reach the single-stock advices. Red triangles highlight the most limiting species for that fleet (“choke species”) whereas the green triangles highlight the least limiting species. (1: Cod; 2: Haddock; 3: Plaice 4; 4: Saithe; 5: Sole 4; 6: Whiting; 7\_1: NEP10; 7\_2: NEP32; 7\_3: NEP33; 7\_4: NEP34; 7\_5: NEP35; 7\_6: NEP6; 7\_7: NEP7; 7\_8: NEP8; 7\_9: NEP9; 7\_10: NEPOTH; 9: Plaice 7d; 10: Sole 7d).

**Quality considerations**

Mixed-fisheries projections build on single-stock assessments, most of which are of high quality and precision. Single-stock forecasts are also reproduced independently as part of the mixed-fisheries analyses, allowing additional quality control of both processes.

The quality of data on catch, disaggregated by métier, has improved in recent years because of the single ICES data call combining data needs and ensuring common data storage in InterCatch for single-stock assessment and mixed-fisheries forecasts.

A key assumption in the forecast is that catchability for fleets remains constant at 2015, but this is heavily dependent on fishing patterns, which may change over time – particularly in response to significant changes in policy, such as the introduction of the landing obligation and the revision of technical rules. In practice, such changes in catchability would affect the outcomes of mixed-fisheries projections. For example, an increase of catchability would imply that a

stock can become more limiting in the “Minimum” scenario, as fewer fishing days would be required to fish up the fleets’ catch share.

Another assumption is that the selectivity is the same for all fleets (based on the F-at-age derived from the assessment). Therefore, changes in the relative contribution of each fleet to the total effort cannot be translated into specific changes in the relative F-at-age. This prevents the use of better selection patterns for some fleets (such as gillnetters) in achieving the MSY approach.

### Issues relevant for the advice

ICES provides five example scenarios. Alternative scenarios that take account of other specific management objectives could be considered. In particular, the EU is currently working on regional mixed-fisheries management plans. These plans would not include the prescriptive single-stock harvest control rules seen in current plans, but would be rather based on  $F_{MSY}$  values with ranges and include biomass safeguards. Such options were evaluated by STECF for the North Sea demersal stocks in spring 2015 (STECF, 2015), using the ICES mixed-fisheries Fcube model with different scenarios. These alternative scenarios can help identify robust management strategies, integrating MSY management objectives with socio-economic considerations. ICES could provide additional scenarios on request from clients.

*Nephrops* are managed on the basis of one TAC for the whole North Sea, while ICES advises on the basis of FUs. For example, catches in 2014 of *Nephrops* in FU 7 were much lower than advised, while catches in FU 6 were higher than advised. The mixed-fisheries analysis is based on the ICES catch advice for the individual FUs. As a consequence, fisheries behaviour between FUs will differ from the modelled runs and this influences the outcomes of the “Maximum” and “Minimum” scenarios.

The effort management scenario is not presented this year as no effort reduction has been implemented since last year (effort roll-over).

### Basis for the assessment

**Table 6.2.3** Mixed-fisheries advice North Sea. The basis of the assessment.

Stock data category	Categories 1 and 4 ( <a href="#">ICES, 2016b</a> ).
Assessment type	Fcube (FLR).
Input data	Assessments on the relevant stocks in the North Sea fisheries working group ( <a href="#">WGNSSK</a> ; ICES, 2016c), catch and effort by fleet and métiers.
Discards and bycatch	Included as in the single-stock assessments.
Indicators	None.
Other information	This assessment was presented for the first time in 2012. As any scenario will result in trade-offs between different fisheries that are informed by more than scientific considerations, no one scenario is presented as advice. The scenarios indicate which stocks will limit, and thus have the greatest influence on the fisheries.
Working group report	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak ( <a href="#">WGNSSK</a> ), Working Group on Mixed Fisheries Advice ( <a href="#">WGMIXFISH-ADVICE</a> ).

### 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 Fcube method (Ulrich *et al.*, 2011; Table 6.2.3). Mixed-fisheries scenarios are based on central assumptions that fleets’ fishing patterns (quota shares per stock, effort allocation to different métiers) and catchability in 2016 and 2017 are the same as those in 2015.

**Table 6.2.4** Mixed-fisheries advice North Sea. Advice and management areas and management plans for the species considered.

Species	ICES single-stock advice area	Management area	Management plan ref(s)
Cod	Subarea 4, Division 7.d, and Subdivision 3.a.20 (North Sea, eastern English Channel, Skagerrak)	<ul style="list-style-type: none"> <li>• EU TAC Skagerrak</li> <li>• EU TAC Division 7.d</li> <li>• Subarea 4; EC waters of Division 2.a; the part of Division 3.a that is not covered by the Skagerrak and Kattegat</li> </ul>	<ul style="list-style-type: none"> <li>• EU and Norway management strategy (STECF, 2015) ^</li> <li>• Council Reg. (EC) No. 1342/2008 (EU, 2008) ^</li> </ul>
Haddock *	Subarea 4, Division 6.a, and Subdivision 3.a.20 (North Sea, West of Scotland, Skagerrak)	<ul style="list-style-type: none"> <li>• EU TAC Division 3.a, EC waters of divisions 3.b, 3.c, and 3.d</li> <li>• Subarea 4; EC waters of Division 2.a</li> <li>• EC and international waters of divisions 5.b and 6.a</li> </ul>	<ul style="list-style-type: none"> <li>• EU and Norway management strategy (not relevant for the new advice unit) (STECF, 2015) ^</li> </ul>
Plaice**	Subarea 4 (North Sea) and Subdivision 3.a.20 (Skagerrak)	<ul style="list-style-type: none"> <li>• Subarea 4; EC waters of Division 2.a; the part of Division 3.a that is not covered by the Skagerrak and the Kattegat</li> <li>• Skagerrak</li> </ul>	<ul style="list-style-type: none"> <li>• Council Reg. (EC) No. 676/2007 (EU, 2007) ^</li> </ul>
Saithe	Subareas 4 and 6 and Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	<ul style="list-style-type: none"> <li>• Division 3.a and Subarea 4; EC waters of divisions 2.a, 3.b, 3.c, and 3.d</li> <li>• Subarea 4; EC waters of Division 5.b; EC and international waters of subareas 12 and 14</li> </ul>	<ul style="list-style-type: none"> <li>• EU and Norway management strategy (STECF, 2015) ^</li> </ul>
Sole	Subarea 4 (North Sea)	<ul style="list-style-type: none"> <li>• EC waters of subareas 2 and 4</li> </ul>	<ul style="list-style-type: none"> <li>• Council Reg. (EC) No. 676/2007 (EU, 2007)</li> </ul>
Whiting ***	Subarea 4 and Division 7.d (North Sea and eastern English Channel)	<ul style="list-style-type: none"> <li>• Subarea 4</li> <li>• EU TAC Subarea 7</li> </ul>	<ul style="list-style-type: none"> <li>• EU and Norway management strategy (STECF, 2015) ^</li> </ul>
<i>Nephrops</i>	Functional units (FUs) in Subarea 4: 5, 6, 7, 8, 9, 10, 32, 33, 34, and other areas outside FUs	<ul style="list-style-type: none"> <li>• EU TAC Subarea 6</li> <li>• Norway: no TAC</li> </ul>	<ul style="list-style-type: none"> <li>• NA</li> </ul>
Plaice	Division 7.d (eastern English Channel)	<ul style="list-style-type: none"> <li>• Divisions 7.d and 7.e</li> </ul>	<ul style="list-style-type: none"> <li>• NA</li> </ul>
Sole	Division 7.d (eastern English Channel)	<ul style="list-style-type: none"> <li>• Division 7.d</li> </ul>	<ul style="list-style-type: none"> <li>• NA</li> </ul>

\* Before 2014 this stock was only assessed for Subarea 4 and Subdivision 3.a.20.

\*\* Before 2015 this stock was only assessed for Subarea 4 (North Sea).

\*\*\* Advice for this stock includes human consumption and industrial landings.

^ Management plan or strategy is not used as the basis for advice.

The species considered here as part of the demersal mixed fisheries are cod, haddock, whiting, saithe, plaice, sole, and *Nephrops*. A large number (12) of the stocks are assessed with analytical assessments. In addition, six *Nephrops* stocks without analytical assessments, but for which quantitative advice is provided, are included. For all stocks except eastern English Channel sole, discards are monitored and included in the assessment. All stocks are not managed within the same management area or with the same management rules (MSY approach or management plan). Table 6.2.4 summarizes the advice area, management area, and management plan for the main stocks. Figure 6.2.4 illustrates the landings by species in the North Sea area per species. Landings by métier aggregated by métiers as defined in the cod management plan (Table 6.2.4 for correspondence) are presented in Figure 6.2.5. Methods to include stocks without analytical assessments in the mixed-fisheries forecasts are currently being developed in order to take account of the potential “choke” species for fleets operating under a landing obligation. Pelagic stocks (herring, mackerel) are not included as they are taken by fisheries subject to little technical interaction.



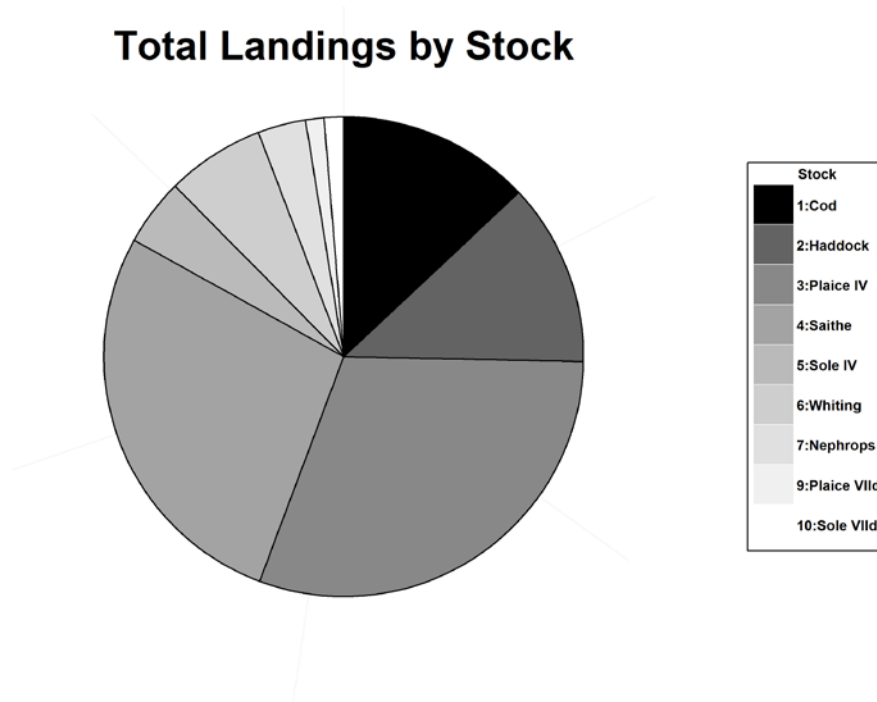


Figure 6.2.3 Mixed-fisheries advice in the North Sea. Catch distribution.

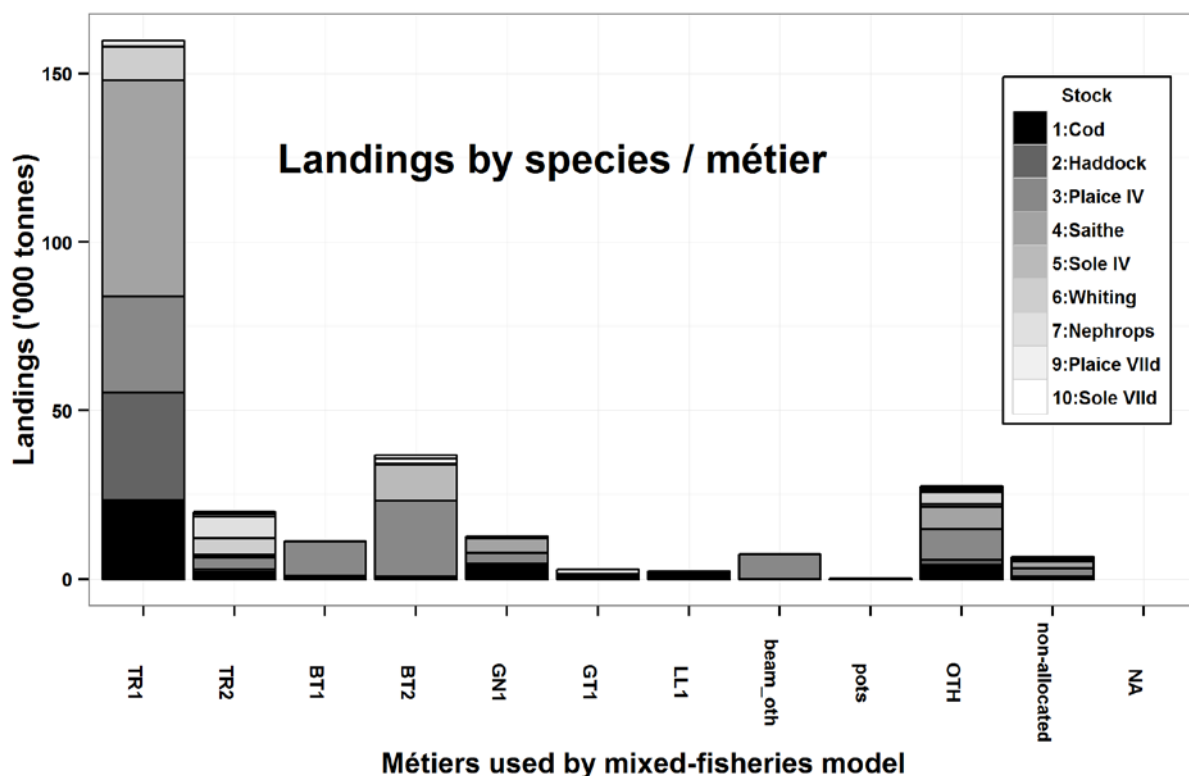


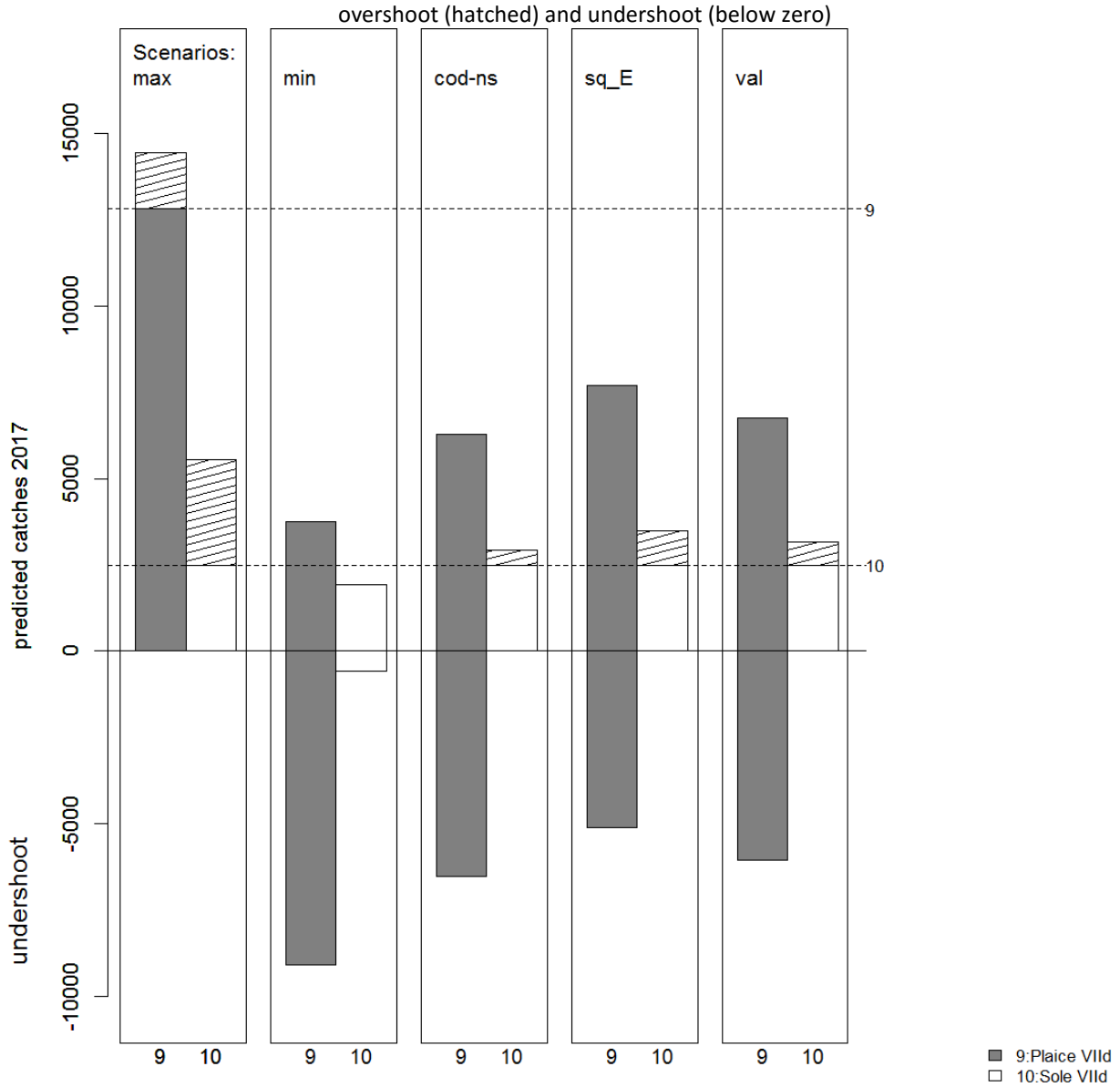
Figure 6.2.4 Mixed-fisheries advice in the North Sea. Landings distribution of species by métier with landings consisting of  $\geq 1\%$  of any of the stocks (see Figure 6.2.1) in 2015 (list of métiers available in Table 6.2.5). Note: The “other” (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and métier with landings  $< 1\%$  of any of the stocks 1–10 in 2014. The “non-allocated” is the differences between total landings used in single-stock advice and mixed-fisheries advice, such as saithe and haddock landings in Subarea 4 and Division 6.a, respectively.



**Table 6.2.5** Mixed-fisheries advice North Sea. Métier categories used in the mixed-fisheries analysis.

Mixed-fisheries metiers	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	NA
Pelagic	Pelagic trawl or seine	
Pots	Pots	NA
OTH	Any gear type	

**Predicted catch for 2017, for flatfish stocks in Division 7d.**  
**Detail from Figure 6.2.1**



**Figure 6.2.5** Mixed-fisheries projections for the stocks subject to lower catches (detail from Figure 6.2.1). Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the single-stock advice for 2017. Bars below the value of zero show the scale of undershoot (compared to single-stock advice) in cases where catches are predicted to be lower when applying the scenario. Hatched columns represent catches that overshoot the single-stock advice.

The projections are presented in terms of total catches, haddock and sole have been under the landing obligation in 2016, and all catches for these species are assumed to count against the fleets' stock shares. For *Nephrops* stocks, a 6% *de minimis* discard ratio is assumed. For all other stocks, only landings (wanted catches) are assumed to count against the fleets' stock share in 2016 and 2017. Fishing mortality values used in the projections still include discards.

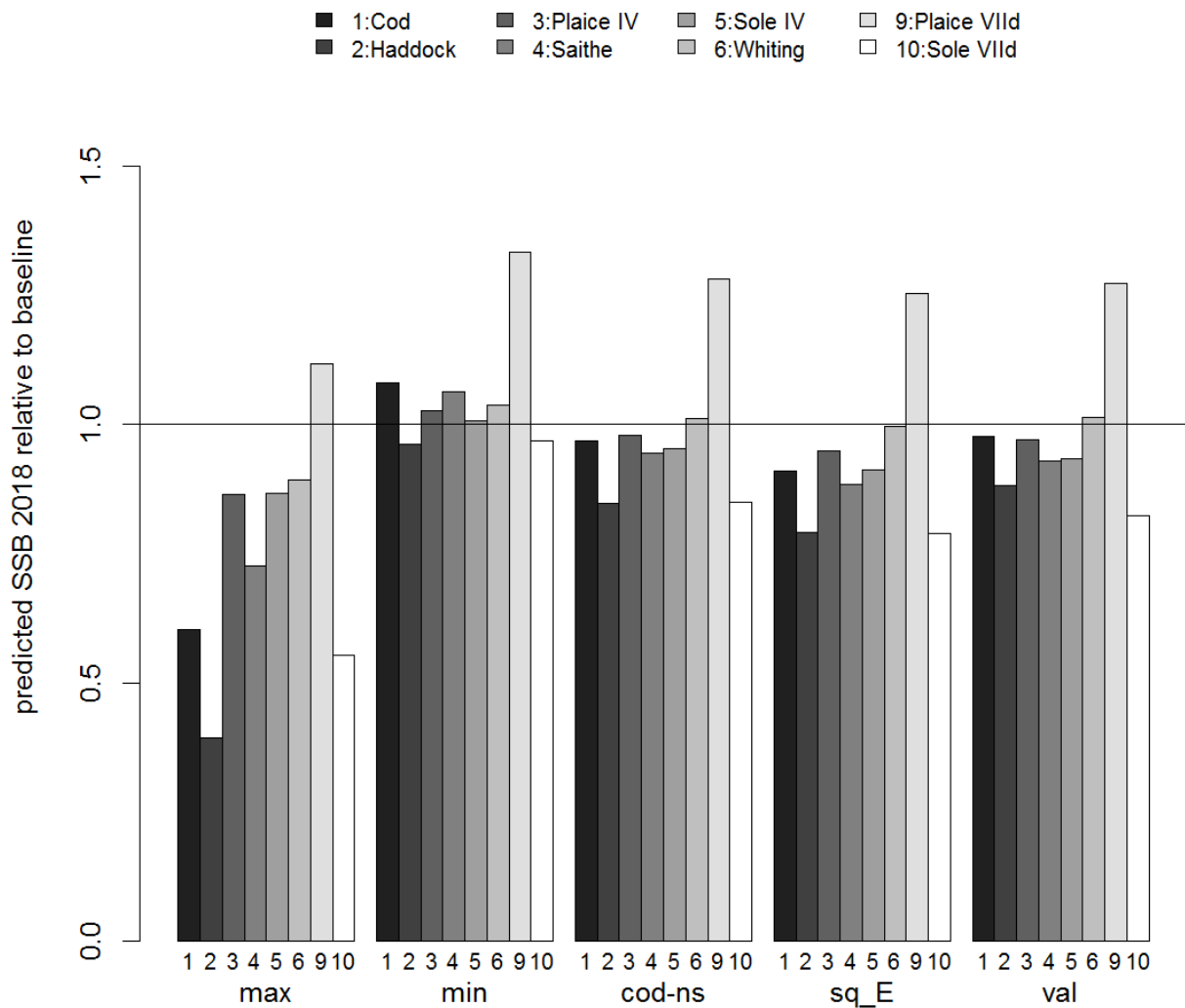
The projections made use of data requested as part of an ICES data call issued formally under the EU Data Collection Framework (DCF) regulations. This provides a much greater consistency between catch totals used in mixed fisheries and single stock advice. To allow consideration of fleets defined by length categories, separate data files containing total weight of landings and effort in kW-days by fleet and métier were used. Fleet and métier categories used in the mixed-fisheries analysis are based on DCF level 6 categories, but merging over DCF categories has been performed to aggregate over "small" métiers (a métier failing to land at least 1.0% in 2015 of at least one of the stocks considered). Because of the different forecasting methods used, differences between catch forecasts estimated by single-stock and mixed fisheries can occur, but this does not affect the conclusions of the analyses. For example, there is a difference of 2592 tonnes (5.4%) between the single-species cod advice and the cod catches in the "Cod" scenario in Figure 6.2.1.

Total landings (2015) of all species considered in the mixed-fisheries advice were 286 670 t, with:

- ~ 63% landed by otter trawls and seines;
- ~ 19% by beam trawls;
- ~ 5% by gill- and trammelnets;
- ~ 1% by longlines;
- ~ 10% by other gears; and
- ~ 2% from other areas (Division 3.a.21 & Subarea 6).

Total discards were 92 003 t (24% by weight of total catch).

Summary of the assessment



**Figure 6.2.6** Mixed-fisheries advice in the North Sea. Estimates of potential SSB at the start of 2018 by stock after applying the mixed-fisheries scenarios, expressed as a ratio to the single-stock advice forecast. The horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2018). *Nephrops* are not included as the abundance was not forecasted in the mixed-fisheries model.

**Table 6.2.6** Mixed-fisheries advice in the North Sea. SSB results from single-stock advice and different mixed-fisheries scenarios (see Figure 6.2.6). *Nephrops* are not included as the abundance is not forecasted in the mixed-fisheries model. All weights are in tonnes. Unless otherwise noted, SSB (2018) >  $B_{pa}$  or MSY  $B_{trigger}$ .

Stock	Single-stock advice	SSB (2018) resulting from mixed-fisheries scenario applied in 2017				
	SSB (2018)	Maximum	Minimum	Cod	Status quo effort	Value
Cod	181374	102988 ***	184511	165509	155275 *	166742
Haddock	205595	79550 ***	194247	171155	159698	178040
Plaice in Division 7.d	59077	66030	78761	75708	74013	75146
Plaice in Subarea 4	1065323	921565	1094476	1043814	1012053	1033153
Saithe	333297	228748	335149	297816	278248	293096
Sole in Division 7.d	944	5212 **	9106	8003	7420 **	7754**
Sole in Subarea 4	76196	66045	76786	72686	69508	71177
Whiting	327559	291485	339295	330424	325713	331053

\*  $B_{lim} < SSB(2018) < B_{pa}$ .

\*\*  $SSB(2018) < B_{pa}$ ,  $B_{lim}$  not defined.

\*\*\*  $SSB(2018) < B_{lim}$ .

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