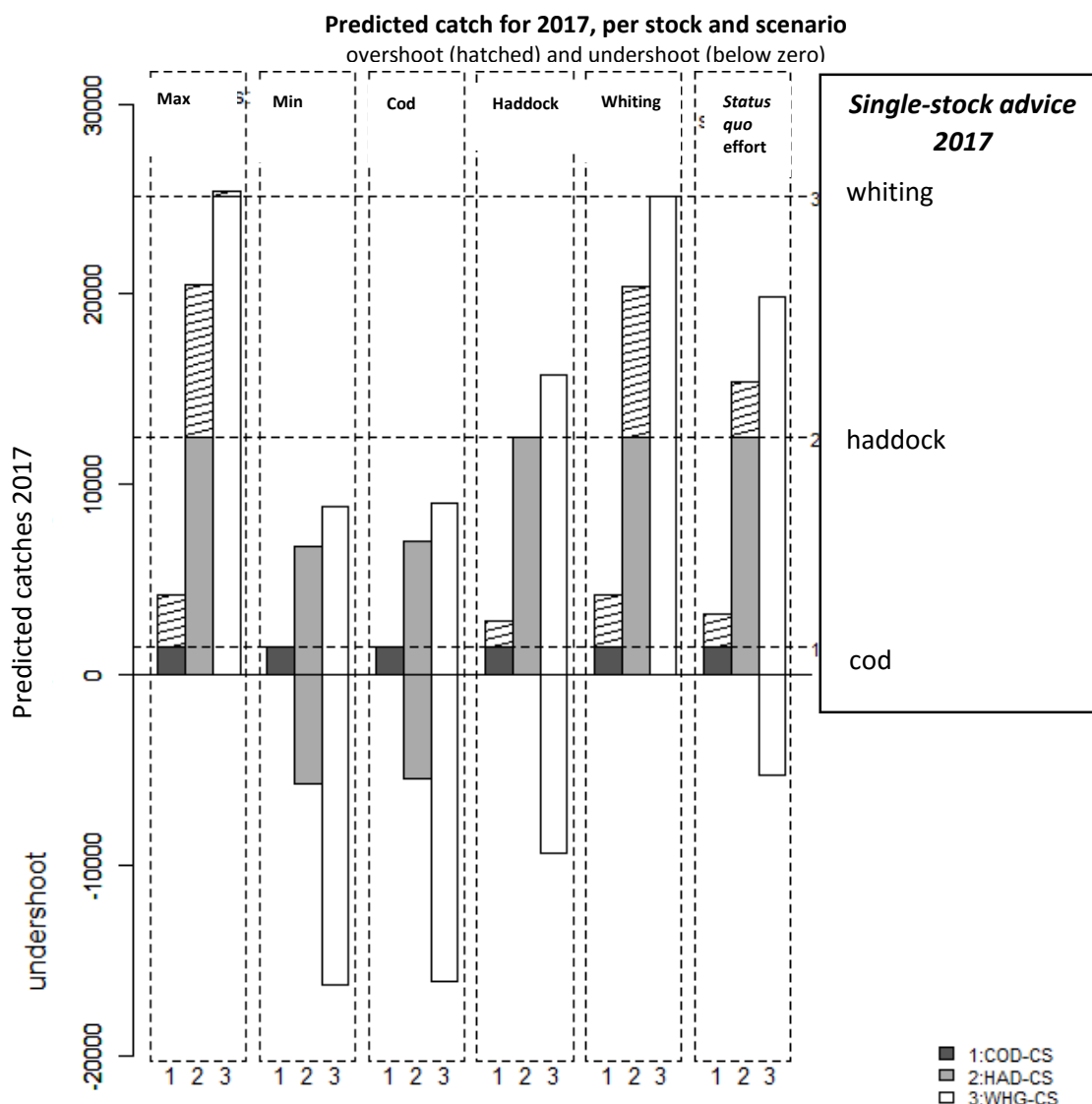


### 5.2.7.2 Mixed-fisheries advice for divisions 7.b–c and 7.e–k (Celtic Sea)

#### Summary

ICES cannot recommend specific mixed-fisheries catch opportunities as no mixed-fisheries management objectives are available. Six example scenarios are presented, taking into account the single-stock advice for fisheries catching cod, haddock, and whiting, as well as fishing patterns and catch compositions observed in 2015. Total catch is forecast, except for cod where discards are uncertain and so only landings are presented.

Under the “minimum” scenario the cod TAC limits catches of haddock and whiting, resulting in a 44% and 64% undershoot in quota uptake, respectively. Under the “maximum” scenario, the whiting TAC is fully utilized but there is an overshoot of the cod and haddock TACs by 193% and 65%, respectively.



**Figure 5.2.7.2.1** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Celtic Sea mixed-fisheries projections. Estimates of potential catches (in tonnes) by stock and by scenario (described in Table 5.2.7.2.1). 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.

## The scenarios

**Table 5.2.7.2.1** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Mixed-fisheries scenarios considered for the Celtic Sea gadoids.

Scenarios	Abbreviation	Explanation
Maximum	Max	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.
Minimum	Min	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 MSY approach	Cod	All fleets set their effort corresponding to that required to catch their cod stock share, regardless of other catches.
Haddock MSY approach	Had	All fleets set their effort corresponding to that required to catch their haddock stock share, regardless of other catches.
Whiting MSY approach	Whg	All fleets set their effort corresponding to that required to catch their whiting stock share, regardless of other catches.
<i>status quo</i> effort	Sq_E	The effort of each fleet is set equal to the effort in the most recently recorded year (2015) for which catch and effort data are available.

\*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 2017 and the historical proportion of the stock landings taken by the fleet.

## Catch options

Mixed-fisheries advice considers the implications of mixed fisheries operating under single-stock TAC limits, taking into account the fishing pattern and catchability of the various fleets in 2015. The scenarios do not assume any amount of quota swapping, balancing, or adaptation of fishing behaviour. Catch options are presented in Table 5.2.7.2.2 under the scenarios described in Table 5.2.7.2.1. The "minimum" scenario is based on the assumption of a strictly implemented discard ban. In 2017, the "minimum" scenario gives similar results to the "cod" scenario, indicating that cod is the most limiting stock for most fleets. In addition to the "minimum" scenario a "maximum" scenario is included. The "maximum" scenario demonstrates the upper bound of potential fleet effort and stock catches in that it assumes all fleets continue fishing until all their stock shares are exhausted, irrespective of the economic viability of such actions. For 2017, the "maximum" scenario gives very similar results to the "whiting" scenario, indicating this is the least limiting quota for most fleets.

In the "minimum" scenario, the most limiting stock is cod for fishing activities that represent 95% of the fishing effort (kW-days) in 2015, with the remaining 5% limited by haddock. In the "maximum" scenario, the least limiting stock is whiting for fishing activities that represent 75% of the effort (kW-days) in 2015, with the remaining 25% limited by haddock. The "maximum" and "whiting" scenarios result in cod being fished above the precautionary level ( $F_{pa}$ ) in 2017, which is therefore not considered precautionary (Table 5.2.7.2.2). All scenarios result in SSB for cod in 2018 falling below the precautionary level ( $B_{pa}$ ), while the "max", "haddock", "whiting", and "*status quo* effort" scenarios result in SSB falling below  $B_{lim}$  (Table 5.2.7.2.3).

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. The ICES single-stock advice for demersal stocks (ICES, 2016a) is based on the ICES maximum sustainable yield (MSY) approach. All scenarios except "minimum" and "cod" result in cod being fished above  $F_{MSY}$ , while all the scenarios except "minimum", "cod", and "haddock" result in haddock being fished above  $F_{MSY}$ . Whiting is fished at or below  $F_{MSY}$  in 2017 in all scenarios except "maximum", reflecting that whiting is the least limiting stock for most fleets.

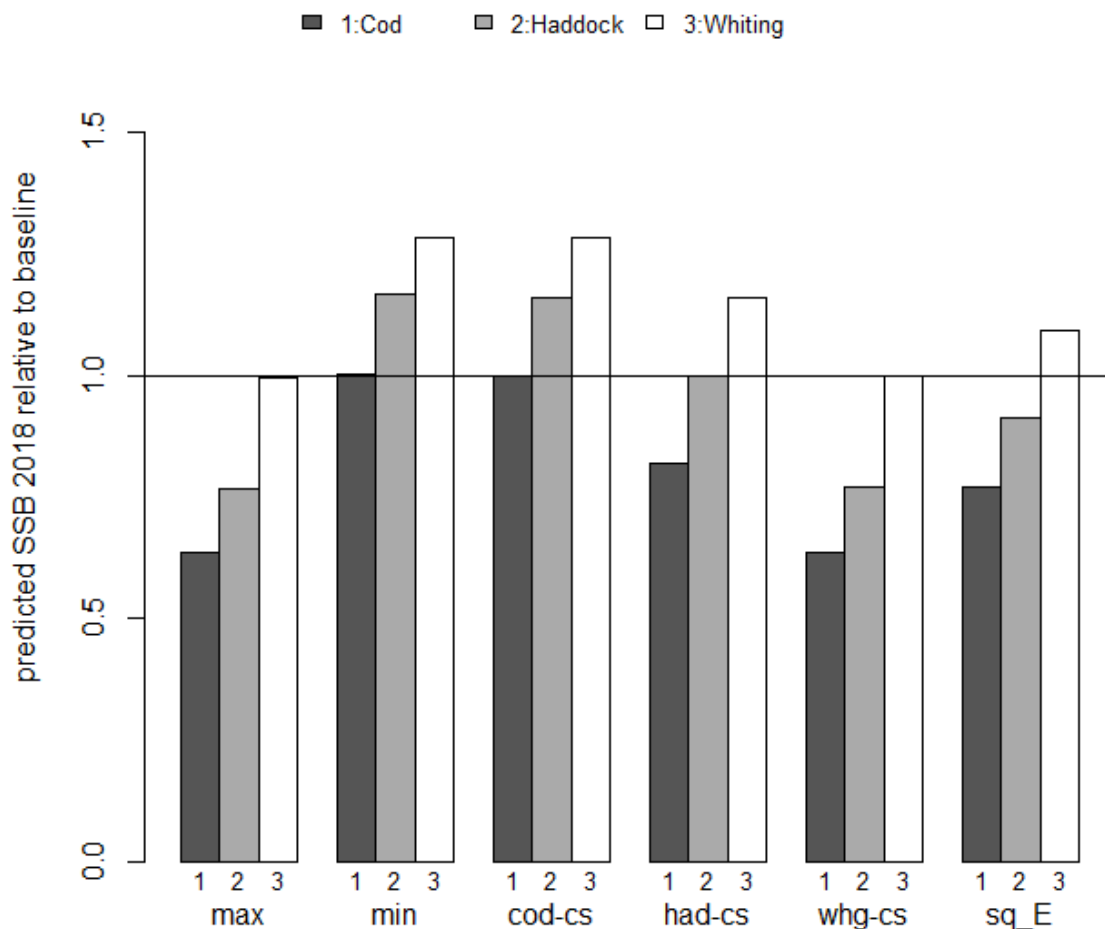
The scenarios do not assume any amount of quota swapping or balancing or adaptation of fishing behaviour. Scenarios that result in under- or overutilization are useful in identifying imbalance between the fishing opportunities of the various stocks. They indicate in which direction fleets may have to adapt to fully utilize their catch opportunities without collectively exceeding single-stock fishing opportunities. Under the scenarios presented here, the "maximum" scenario suggests that if all fleets' stock shares are to be fully utilized, catches of cod and haddock would be considerably higher than advised in the

single-stock advice. A significant change to the exploitation pattern for cod and haddock (i.e. a reduction in catches relative to whiting) would be required in 2017 to avoid overexploitation of these stocks, or underexploitation of whiting.

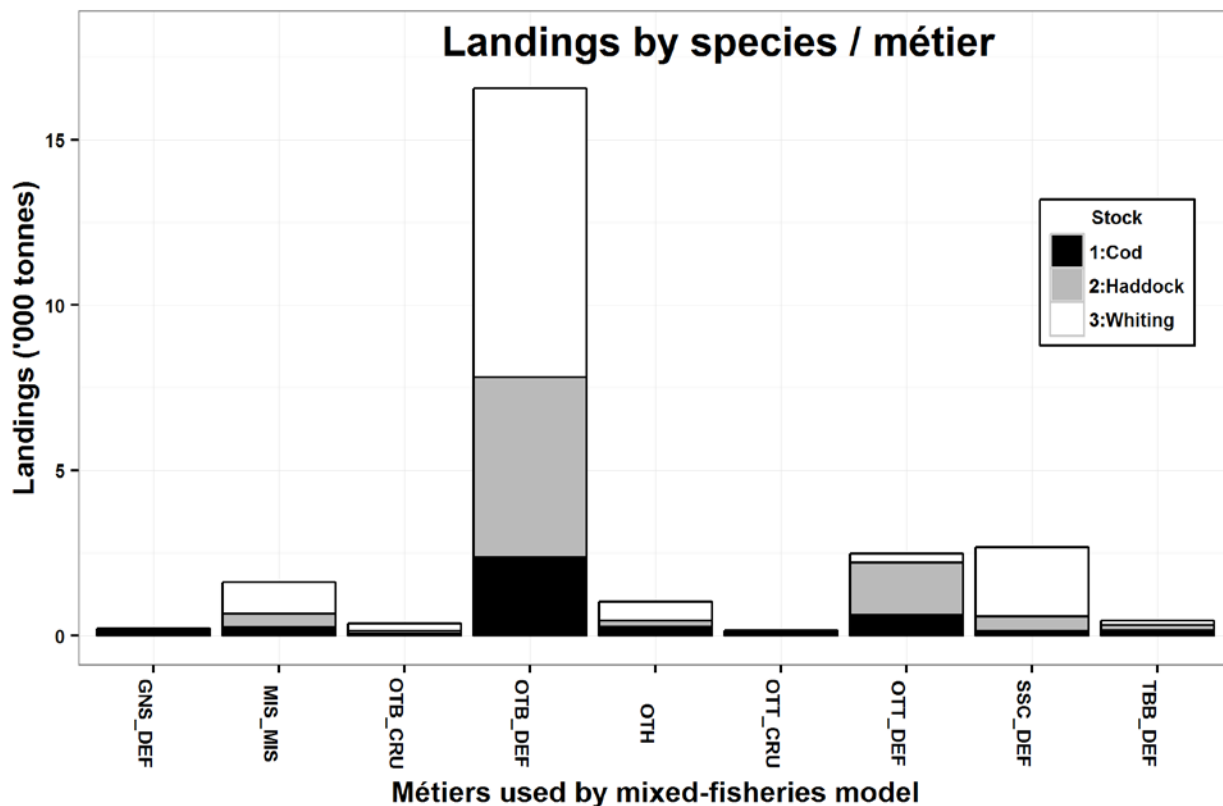
Of the presented scenarios, only the “minimum” and “cod” scenarios meet the objective of all stocks being fished at or below  $F_{MSY}$ . For most fleets this implies reducing effort levels by 60% compared to those observed in 2015. It also means the whiting and haddock TACs at  $F_{MSY}$  cannot be fully utilized in the mixed gadoid fisheries if cod is to be fished at  $F_{MSY}$ . In contrast to single-stock advice there is no single recommendation, but a range of plausible 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 for all stocks considered simultaneously.

The “minimum” scenario assumes that all catch (including any discards) will be counted against the quota. The analysis highlights where fleets with a small share but high discard rate for a stock have their fishing activity limited by that stock, resulting in underutilization of their target stock(s). Supporting measures aimed at minimizing the misalignment between activity and stock shares for the fleets, such as changes in gear selectivity, spatio-temporal management measures, or re-allocation of stock shares, may be required if fishing opportunities are to be fully taken under a fully implemented landing obligation.

There are no specific management plans in place for cod, haddock, or whiting in the Celtic Sea.



**Figure 5.2.7.2.2** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. 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 indicates the SSB resulting from the single-stock advice (at the start of 2018).



**Figure 5.2.7.2.3** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Landings distribution of species by métier with landings consisting of  $\geq 1\%$  of any of the stocks (see Table 5.2.7.2.6) in 2015 (list of métiers available in Table 5.2.7.2.4). 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 1–3 (Table 5.2.7.2.6) in 2015.

**Table 5.2.7.2.2** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. TAC year (2017) fishing mortality forecast by scenario. The F range is averaged across the same ages as those used for the single-stock assessment.

Stock	Single-stock F advice 2017	Basis for the advice	F per mixed-fisheries scenario in 2016					
			"max"	"min"	"cod"	"had"	"whg"	"Sq_E"
Cod 7.e–k	0.21	MSY approach	0.77	0.21	0.21	0.45	0.76	0.53
Haddock 7.b–k	0.40	MSY approach	0.75	0.20	0.21	0.40	0.75	0.52
Whiting 7.b–c and 7.e–k	0.52	MSY approach	0.53	0.15	0.16	0.29	0.52	0.39

*legend*

	$F_{2017} \leq F_{msy}$
	$F_{2017} > F_{msy}, < F_{pa}$
	$F_{2017} > F_{pa}$
	$F_{2017} > F_{lim}$

**Table 5.2.7.2.3** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. SSB results from single-stock advice and different mixed-fisheries scenarios (see Figure 5.2.7.2.2). Weights in thousand tonnes.

Stock	Single-stock advice	SSB (2018) resulting from mixed-fisheries scenario applied in 2017					
	SSB in 2018	"max"	"min"	"cod"	"had"	"whg"	"Sq_E"
Cod 7.e–k	8.312	5.270	8.340	8.312	6.791	5.291	6.398
Haddock 7.b–k	34.408	26.418	40.169	39.940	34.408	26.467	31.440
Whiting 7.b–c and 7.e–k	49.360	49.133	63.397	63.258	57.325	49.360	53.866

**legend**

	SSB 2018 > $B_{pa}$ or $MSY B_{trigger}$
	SSB 2018 > $B_{lim}$ , no $B_{pa}$ defined
	SSB 2018 > $B_{lim}$
	SSB 2018 < $B_{lim}$

**Table 5.2.7.2.4** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Métier categories used in the mixed-fisheries analysis.

Mixed-fisheries métiers	Gear	Target species
OTB_DEF	Otter trawls	Demersal fish
OTT_DEF	Twin otter trawls	Demersal fish
SSC_DEF	Scottish seines	Demersal fish
GNS_DEF	Gillnets	Demersal fish
TBB_DEF	Beam trawls	Demersal fish
OTB_CRU	Otter trawls	Crustaceans
OTT_CRU	Twin otter trawls	Crustaceans
MIS_MIS / OTH	Other gears	Any

**Methods and data**

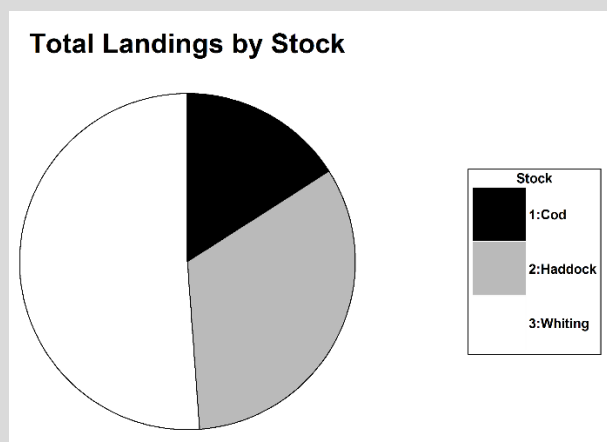
Mixed-fisheries considerations are based on the single-stock assessments combined with knowledge on the species composition in catches in the Celtic Sea fisheries, using the Fcube method (Ulrich *et al*, 2011). Mixed-fisheries scenarios are based on central assumptions that fishing patterns and catchability in 2017 are the same as those in 2015. The same F assumption in 2016 is made as for the single-stock advice (*status quo* F, average 2013–2015).

This mixed-fisheries forecast is limited to three gadoid stocks with full analytical single-species assessments, cod, haddock, and whiting (Table 5.2.7.2.5). Projections are presented in terms of catch. Total catch is forecast based on current selection patterns observed in the fisheries (in 2015), except for cod where discards are uncertain and so only landings are presented. The reference points for the included stocks can be found in the 2016 single-stock advice sheets (ICES, 2016b, 2016c, and 2016d) and the 2015 relative catch distribution is shown in Table 5.2.7.2.6. Plaice and sole were also considered for inclusion but are thought to have limited technical interaction with the gadoid stocks (ICES, 2015). Pelagic species (e.g. herring, mackerel, horse mackerel) are not included as they are mainly taken by fisheries subject to little technical interaction.

Further work is ongoing to include additional analytical stocks (e.g. the *Nephrops* stocks). Methods to include stocks without analytical assessments in the mixed-fisheries forecasts based on catch per unit effort are also being developed in order to take account of the potential “choke” species for fleets operating under a landing obligation.

**Table 5.2.7.2.5** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Advice and management area for the three gadoid species considered.

Species	ICES single-stock advice area	Management area
Cod	Divisions 7.e–k	EU TAC divisions 7.b–c and 7.e–k and subareas 8–10; EU waters of CECAF 34.1.1
Haddock	Divisions 7.b–k	EU TAC divisions 7.b–k and subareas 8–10; EU waters of CECAF 34.1.1
Whiting	Division 7.b–c and 7.e–k	EU TAC divisions 7.b–e, 7.f–h, and 7.j–k

**Table 5.2.7.2.6** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. Landings distribution.

Total landings (2015) of all species considered in the mixed-fisheries advice were 25 534 t, with:

- ~ 85% landed by otter trawls and seines;
- ~ 3% by beam trawls;
- ~ 2% by gill- and trammelnets; and
- ~ 10% by other gears.

Total discards (not shown in the plot) were 12 869 t (34% by weight of total catch). Cod discards are not included in the analysis.

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 supplied to ICES. 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 also requested. Fleet and métier categories used in the mixed-fisheries analysis are based on DCF level 5 categories, but merging over DCF categories has been performed to aggregate over “small” métiers (defined as a métier with less than 1.0% landed in 2015 for each of the stocks considered).

**Table 5.2.7.2.7** Mixed-fisheries advice for divisions 7.b–c and 7.e–k. The basis of the assessment.

ICES stock data category	1 ( <a href="#">ICES, 2016a</a> )
Assessment type	Fcube (FLR), (Ulrich <i>et al</i> , 2011).
Input data	Assessments on the relevant stocks in the Celtic Sea Ecoregion fisheries working group ( <a href="#">WGCSE</a> ), catch and effort by fleet and métiers.
Discards and bycatch	Included as in the single-stock assessments, where possible.
Indicators	None
Other information	This assessment was first presented in 2014 at the MIXFISH-METHODS (ICES, 2015). As any scenario results 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 influence, the fisheries most.
Working group report	Working Group on the Assessment of Demersal Stocks in the Celtic Sea Ecoregion ( <a href="#">WGCSE</a> ) and Working Group on Mixed Fisheries Advice ( <a href="#">WGMIXFISH-ADVICE</a> )

### Quality considerations

To maintain consistency with the single-stock advice, the mixed-fisheries analysis is based on total catch (landings and discards) for haddock and whiting, but only landings for cod.

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.

Mixed-fisheries projections for the Celtic Sea build on full analytical single-stock assessments. Single-stock forecasts are also reproduced independently as part of the mixed-fisheries analyses, allowing additional quality control of both processes. The quality of the individual forecasts of the single stocks may affect the results of the mixed-fish scenarios. An error or bias in the forecast of one stock could lead to an inappropriately low or high TAC for this stock. This would, in turn, affect the estimated effort required for each métier to land this TAC. If the effort required to land the TAC for this stock is pivotal in any

of the scenarios examined, this would affect the exploitation prognoses of the other stocks in this scenario. In other words, the quality of the mixed-fisheries model is limited by the stock which has the most biased assessment, if that stock is the limiting factor in a mixed-fisheries scenario.

Mixed-fisheries scenarios are based on central assumptions that fishing patterns and catchability in 2017 are the same as those in 2015 (similar to procedures in single-stock forecasts where growth and selectivity are assumed constant). A key assumption in the forecast is that catchability for fleets remains constant, 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 a landing obligation. At present a series of technical measures are in place for demersal trawl gears operating in various parts of the Celtic Sea. This includes maximum number of meshes in circumference and minimum mesh size, depending on the target composition and/or area. More recently square mesh panels (SMP) were introduced. The aims of these technical measures is to change catchability by improved selection within the Celtic Sea fisheries, reducing catches of small whiting and haddock. Depending on the efficacy of the measures as implemented in practice there will be short-term changes in catchability which are assumed to be fixed in the mixed-fisheries forecast. The conclusion that cod is the most limiting species in the Celtic Sea mixed fisheries is robust to this because the SMP measures are least effective for cod.

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 are not translated into specific changes in the relative F-at-age. This prevents that the use of better selection patterns for some fleets (such as gillnetters) in achieving the MSY approach can be taken into account. The possibility of using catch-at-age by fleet through the Intercatch database is being investigated.

A change this year is to assume that fishing mortality in the intermediate year is equal to the mean F in 2013–2015 (the same as for the single-stock advice). This differs from last year's mixed-fisheries advice where effort in 2014 was assumed for the intermediate year (2015), providing more consistency with single-stock catch advice for 2017.

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