

# ICES WGMIXFISH–ADVICE REPORT 2017

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## Report of the Working Group on Mixed Fish– eries Advice (WGMIXFISH–ADVICE)

22–26 May 2017

Copenhagen, Denmark



**ICES**  
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International Council for  
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## Executive summary

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The ICES Working Group on Mixed Fisheries Advice [WGMIXFISH-ADVICE] (Chair: Youen Vermard (FR)) met at ICES HQ, 22–26 May 2017 to produce mixed fisheries forecasts for the North Sea, the Celtic Sea and the Iberian waters.

Mixed fisheries advice highlights the potential implications of single stock (Total Allowable Catch and Effort) management on the catches of multiple stocks caught together in mixed fisheries. It takes into account past fishing patterns and catchability of the different fleets and the TAC advice produced by the single stock advice groups for 2018 to provide quantitative forecast of over- and under- exploitation of the different stocks given mixed fishery interactions. All forecasts were based on the “Fcube” (Fleet and Fishery Forecasts) methodology with a range of potential management scenarios relevant for the specific regional fisheries.

For the North Sea (Term of Reference ‘a’) the species considered as part of the demersal mixed fisheries were cod, haddock, whiting, saithe, plaice, sole, and *Nephrops norvegicus*, as well as plaice 7.d and sole 7.d. The limiting TAC will be the TAC for haddock, whiting, and to a lesser extent Norway lobster in FU 6, which are the stocks for which the TACs are almost entirely taken when assuming that fishing fleets stop fishing once they have reached their first quota (scenario “Min”). Otherwise, substantial overshoot of TACs may occur (“Max” scenario). A “range” scenario is presented this year, in which the potential for TAC mismatch in 2018 are minimized within the  $F_{MSY}$  range for demersal fish stocks where such a range is available. This scenario returns a fishing mortality by stock which, if used for setting single stock fishing opportunities for 2018, may reduce the gap between the most and the least restrictive TACs, thus reducing the potential for quota over- and undershoot. This “range” scenario suggests that the potential for mixed-fisheries mismatch would be lowered with a 2018 TAC in the lower part of the  $F_{MSY}$  range for eastern Channel plaice and saithe, and in the upper part of the range for cod and North Sea plaice..

For the Celtic Sea (Term of Reference ‘b’) the species considered as part of the gadoid fisheries were cod, haddock and whiting. The most limiting stock (i.e. the stock where the first quota is reached for most fleets) in the Celtic Sea gadoid mixed fisheries in 2018 will be cod haddock. The least limiting stock (i.e. the stock which was the last quota to be fulfilled) will be whiting.

The meeting produced a Celtic Sea Mixed Fisheries Advice sheet and included outcomes of the mixed fisheries scenarios in the single species advice sheets (for those stocks considered) for consideration by the ACOM advice drafting group. The meeting also developed a mixed fisheries annex for the region and considered how *Nephrops* stocks could be included in future mixed fisheries forecasts. A “range” scenario is also presented this year for the Celtic Sea, in which the potential for TAC mismatch in 2018 are minimized within the  $F_{MSY}$  range for demersal fish stocks where such a range is available. This scenario returns a fishing mortality by stock which, if used for setting single stock fishing opportunities for 2018, may reduce the gap between the most and the least restrictive TACs, thus reducing the potential for quota over- and undershoot. The ‘range’ scenario suggests that TAC for cod is set slightly higher than the single stock advice, the haddock TAC is set between the  $F_{MSY}$  estimate and the upper end of the range and the TAC for whiting set lower than the single stock advice, at the bottom of its range.

For the Iberian waters (Term of reference 'c') the species considered as part of the demersal mixed fisheries were hake, four-spot megrim, megrim and white anglerfish. The most limiting stocks (i.e. the stock where the first quota is reached for most fleets) in the Iberian waters mixed fisheries will be hake. The least limiting stock (i.e. the stock which was the last quota to be fulfilled) was the white anglerfish.

## 1 Introduction

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### 1.1 Background

The **Working Group on Mixed Fisheries Advice** [WGMIXFISH-ADVICE] (Chair: Youen Vermard (FR)) met at ICES HQ, 22–26 May 2017 to apply mixed fisheries forecasts to the North Sea, Celtic Sea and Iberian waters single species advice and to continue developing mixed fisheries forecasts in the Bay of Biscay to be able to produce mixed fisheries forecast in that area in 2018. WGMIXFISH advice is considered by the relevant advice drafting group alongside the single species advice, and so the WG can only consider preliminary single stock advice. The output from this group applies the methodology developed by the ICES Workshop on Mixed Fisheries Advice for the North Sea [WKMIXFISH] (ICES, 2009a) and Ad hoc Group on Mixed Fisheries Advice for the North Sea [AGMIXNS] (ICES, 2009b) which met in 2009.

The current interest in fleet- and fishery-based approaches has its origins around 2002, when the conflicting states of the various demersal stocks in the North Sea made the limitations of the traditional, single-species approach to advice particularly apparent. The history of the adoption and development of the Fcube approach (after Fleet and Fishery Forecast) used by this WG is detailed in ICES (2009a). At WGMIXFISH 2011 the WG considered steps to fuller integration of mixed fisheries forecasts into single stock advice. Most of the steps recommended have been implemented starting in 2012.

Mixed fishery advice is based on the Common Fisheries Policy (CFP) TAC regime and is consistent with relative stability. The circumstances of 2002 have also led to the introduction of effort restrictions alongside TACs as a management measure within EU fisheries and there has been an increasing use of single-species multi-annual management plans, partly in relation to cod recovery, but also more generally.

The 2014 revision of the CFP introduced a landings obligation in EU demersal fisheries from 2016 alongside regional multi-annual (mixed fishery) management plans. These developments are of key importance for the general approach to mixed-fisheries advice, which must build on the existing legal and management system. While mixed fisheries objectives are under development and therefore cannot yet be incorporated in the mixed fisheries forecasts, the introduction of the landings obligation will fundamentally change how fisheries are managed in the EU. As such, as in 2016 the advice was provided in the context of catch, rather than landings as in previous years. This reflects the move towards a landings obligation for EU fisheries in a phased approach started in 2016.

In order to give input to the regional multi-annual (mixed fishery) management plans, the 'Optim' scenario developed in (Ulrich *et al.*, 2017) was also presented in this advice. This scenario takes advantage of the  $F_{MSY}$  ranges to provide advice that might reduce the inconsistencies between single species advices in a mixed fisheries context.

The mixed fisheries advice has greatly benefited in recent years from the joint single stock and mixed fisheries data calls. From 2015, ICES introduced a single combined data call across all working groups which further improved consistency between the fleet and fishery data used by MIXFISH and the single stock data provided through InterCatch. The latest data call used by WGMIXFISH can be found here: <http://www.ices.dk/marine-data/tools/Pages/Data-calls.aspx>.

## 1.2 Definitions

Two basic concepts are of primary importance when dealing with mixed-fisheries, the Fleet (or fleet segment), and the Métier. Their definition has evolved with time, but the most recent official definitions are those from the CEC's Data Collection Framework (DCF, Reg. (EC) No 949/2008 and Commission Decision 2010/93/UE), which we adopt here:

*A Fleet segment* is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.

*A Métier* is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area and which are characterized by a similar exploitation pattern.

From 2012 WGMIXFISH has requested data according to aggregations based on the definitions of the EU Data Collection Framework (DCF). The data call allowed merging across DCF métiers and as such national data entries were sometimes not by métier in the strict sense. Merging of métiers to reduce to a manageable number going forwards in the forecasts further leads to the formation of combined or 'supra-métiers'.

## 1.3 Terms of Reference

The terms of reference for WGMIXFISH were as follows:

2016/2/ACOM19The **Working Group on Mixed Fisheries Advice** (WGMIXFISH-ADVICE), chaired by Youen Vermard, France, will meet at ICES Headquarters 22–26 May, 2017 to:

- a) Carry out mixed demersal fisheries projections for the North Sea taking into account the single species advice for cod, haddock, whiting, saithe, plaice, sole, turbot, *Nephrops norvegicus*, sole 7.d and plaice 7.d that is produced by WGNSSK in May 2017, and the management measures in place for 2017;
- b) Carry out mixed demersal fisheries projections for the Celtic Sea taking into account the single species advice for cod, haddock, and whiting that is produced by WGCSE in 2017, and the management measures in place for 2017 and further develop advice for the region;
- c) Carry out mixed fisheries projections for the Iberian waters taking into account the single species advice for hake, four-spot megrim, megrim and white anglerfish that is produced by WGBIE in May 2017, and the management measures in place for 2017 and further develop advice for the region;
- d) Produce draft mixed-fisheries sections for the ICES advisory report 2017 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, Celtic Sea, and Iberian waters.

WGMIXFISH-Advice will report by 2 June 2017 for the attention of ACOM



## 2 North Sea

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### 2.1 Background

#### 2.1.1 Effort limitations

For vessels registered in EU member states, effort restrictions in terms of days at sea were introduced in Annex XVII of Council Regulation 2341/2002 and amended by Council on an annual basis. In 2008 the system was radically redesigned. For 2009 effort limits were changed to be on the basis of KWdays effort pots assigned per nation per fleet effort category. The baselines assigned in 2009 were based on track record per fleet effort category averaged over 2004–2006 or 2005–2007 depending on national preference. The latest effort allocations available by nation and gear are given in Appendix 1 of Annex IIa of Council Regulation (EU) 2016/72. The totals in 2016 are unchanged from those in 2012. Member states are permitted slightly larger allocations of effort in cases where that effort involves low cod catches, e.g. through the implementation of more selective gears or cod avoidance measures. Full details are given in Article 13 of Council Regulation (EC) 1342/2008.

#### 2.1.2 Stock-based management plans

For the majority of the stocks considered here as part of the demersal mixed fisheries of the North Sea, the ICES MSY approach or Data Limited Stock (DLS) approach is used as the basis of advice. Multi-annual management plans (MAP) were not used as basis for advice in 2017 for most of the species as the redefinition of the stock definition and/or reference points changed the basis for MAP. The last stock under MAP is the North Sea Sole Council Reg. (EC) No. 676/2007 (EU, 2007), this plan consists of harvest rules to derive annual TACs depending on the state of the stock relative to biomass reference points and target fishing mortality. The harvest rules also impose constraints on the annual percentage change in TAC.

In the frame of the new CFP, the EU is currently working on designing and evaluating mixed-fisheries management plans, that would eventually replace the current single stock LTMPs by a unique framework defining objectives and constraints for both target and bycatch demersal species. A public consultation was opened from February to May 2015<sup>1</sup> with potential outcomes of a mixed-fisheries plan evaluated by STECF in March 2015<sup>2</sup>. A draft version was published by the EC in August 2016<sup>3</sup>, and is still under discussion with the co-legislators, the Council and European Parliament<sup>4</sup>.

Until further progresses are reached with this initiative, the current LTMPs are still in effect, although ICES does not use them for the basis of advice.

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<sup>1</sup> [http://ec.europa.eu/dgs/maritimeaffairs\\_fisheries/consultations/north-sea-multiannual/index\\_en.htm](http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/north-sea-multiannual/index_en.htm)

<sup>2</sup> [http://stecf.jrc.ec.europa.eu/documents/43805/969556/2015-05\\_STECF+15-04+-+NSMAP\\_JRCxxx.pdf](http://stecf.jrc.ec.europa.eu/documents/43805/969556/2015-05_STECF+15-04+-+NSMAP_JRCxxx.pdf)

<sup>3</sup> <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016PC0493&from=EN>

<sup>4</sup> <https://epthinktank.eu/2016/10/05/multiannual-plan-for-north-sea-demersal-fisheries-eu-legislation-in-progress/>

## 2.2 Fcube

### 2.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.*, 2007; [www.flr-project.org](http://www.flr-project.org); FLCORE 2.5.0, FLAssess 2.5.0, Flash 2.5.0) running with R 3.1 (R Development Core Team, 2011). All forecasts were projected using the same `fwd()` function in the Flash Package. The Fcube method is developed as a stand-alone script using FLR objects as inputs and outputs. Software used in the single species assessments and forecasts was as outlined in the text table below.

SPECIES	ASSESSMENT	FORECAST
COD 4, 3.a and 7.d	SAM	SAM
HADDOCK 4, 3.a and 7.d	TSA	MFDP
PLAICE 4	AAP	AAP
SAITHE 4, 3.a and 6	SAM	SAM
SOLE 4	AAP	FLR 2.3, FLSTF
WHITING 4 and 7.d	FLR 2.x, FLXSA	MFDP
PLAICE 7.d	AAP	FLR 2.x, FLSTF
SOLE 7.d	XSA	MFDP

### 2.2.2 Scenarios

The Fcube model has been presented and described in Ulrich *et al.* (2008; 2011 and 2017 for the 'range' scenario). Brief details are presented below and a summary of the methodology is incorporated in the North Sea Mixed Fisheries Annex (see Annex 4)

The basis of the model is to estimate the potential future levels of effort by a fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

Single-species ICES advice is given according to a single preferred option; management plan if implemented, MSY approach otherwise. The basis for each single stock advice is retained in the current mixed-fisheries framework.

A complicating factor when incorporating *Nephrops* is the fact that the species is found in a number of distinct areas or functional units (FU), only some of which receive an abundance estimate (necessary to calculate a catchability). This WG followed the approach adopted by ICES (2009b) which is to perform the normal Fcube prediction for those FUs with absolute abundance estimates, then to calculate a ratio of change (R) from the current yields to the ICES advice for the same FUs. For those FUs without absolute abundance estimates, landings resulting from the Fcube run were simply taken to be the most recently recorded landings multiplied by the same ratio R. To do this, landings for each métier had to be apportioned across the FUs. This was facilitated by the supply of effort and catch data by FU.

Prior to 2009, precursors to WGMIXFISH compiled age-disaggregated data over a large number of categories. Analyses in 2008 highlighted that the age composition of landings showed distinct differences to that supplied to the single species stock assessment working group (WGNSSK) and therefore WGMIXFISH runs projections on the basis of total landings and discards alone. Since 2012, age distribution by métier and area have been increasingly available to WGNSSK in InterCatch. For 2016 data, the match

between InterCatch and fleet data was very good (Table 2.2.1), and age-specific fleet projections will be performed in October 2017 during WGMIXFISH-METH.

As in previous years, the following seven options (or scenarios) were included in the advice:

- 1) **max**: The underlying assumption is that fishing stops for a fleet when all quota species are fully utilized for that fleet with quotas set corresponding to single stock exploitation boundary for each species.
- 2) **min**: The underlying assumption is that fishing stops for a fleet when the catch for the first quota species for that fleet meets the corresponding single stock exploitation boundary.
- 3) **“HAD”** where effort would decrease in 2017 and 2018 compared to 2016 following the constraining haddock TACs
- 4) **“POK”** where the effort would increase in 2017 and 2018 following the large saithe TACs.**sq\_E**: The effort for each fleet is set equal to the effort in the most recently recorded year for which landings and discard data were available.
- 5) **“Value”**: this is a simple scenario incorporating elements of 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 quota of each of the stocks, weighted by the historical catch value of that stock. This option causes over-fishing of some stocks and underutilisation of others
- 6) This year, a **“range”** scenario is presented, as described in Ulrich et al. (2017). This scenario searches for the minimum sum of differences between potential catches by stock under the “min” and the “max” scenarios within the  $F_{MSY}$  ranges.

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 would need 100 days fishing for catching its share of stock A, and 200 days fishing for catching its share of stock B, and if the value (tonnage × mean price in 2014) 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.

## 2.3 Stock input data and recent trends

### 2.3.1 Stocks

#### 2.3.1.1 Data

The assessment data for the different stocks were taken from ICES WGNSSK (2017). Similar to last year, all stock inputs formatted as FLStock objects were directly provided to WGMIXFISH by the respective stock coordinators, and this eased greatly the quality of the process of collecting stock data.

An increasing number of WGNSSK stocks are being assessed using stochastic assessments (SAM model for North Sea cod and saithe, TSA for Northern shelf haddock and AAP for the Eastern Channel plaice, North Sea sole and plaice). These also make use of stochastic projections, which cannot easily be fully replicated in the deterministic Fcube software. However, Fcube projections are routinely compared to the median projections of the single species stochastic forecasts on which single stock advice is

based and results are very similar (see Section 2.5.2.1); as such WGMIXFISH does not consider the difference impacts significantly on the mixed fisheries advice.

*Nephrops* stocks were incorporated in the evaluation by functional unit. For the *Nephrops* stocks in FU5, FU6, FU7, FU8, FU9, FU32, FU33, FU34 and *Nephrops* from areas outside the functional units, the ICES advices were taken for the  $F_{MSY}$  approach.

The functional units with separate stock indices from underwater surveys (FU6, FU7, FU8 and FU9) were treated as separate *Nephrops* identities in the projections whereas the five other functional units (FU 5, 10, 32, 33 and 34) and catches outside the functional units in the North Sea were omitted in the projections.

#### **2.3.1.2 Trends and advice**

**This advice is drafted by the WGNSSK-2017 before considerations by ACOM.**

Recent trends are described on a stock-by-stock basis in ICES (2017), and latest advice by stock is available on the ICES website. In order to give a global overview of all North Sea demersal stocks at one time, this information is summarized below. It should be noted that although there is only one advice, additional management considerations are also listed in the single species advice. Table 2.3.1.2 lists the final advised TACs for 2018 and expected SSBs in 2019

Table 2.3.1.2.1 Analytical stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2018																																									
cod.27.47d20 (Cod)	Subarea 4 (North Sea) and Divisions 7.d (Eastern Channel) and 3.a West (Skagerrak)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th rowspan="2">Status</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2014</th> <th>2015</th> <th>2016</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum sustainable yield</td> <td><math>F_{MSY}</math></td> <td>✗</td> <td>✗</td> <td>Above</td> <td><math>MSY B_{trigger}</math></td> <td>✗</td> <td>✗</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary approach</td> <td><math>F_{pa}</math>, <math>F_{lim}</math></td> <td>○</td> <td>✓</td> <td>Harvested sustainably</td> <td><math>B_{pa}</math>, <math>B_{lim}</math></td> <td>○</td> <td>○</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> </tr> </tbody> </table>		Fishing pressure			Status	Stock size			2014	2015	2016	2015	2016	2017	Maximum sustainable yield	$F_{MSY}$	✗	✗	Above	$MSY B_{trigger}$	✗	✗	Above trigger	Precautionary approach	$F_{pa}$ , $F_{lim}$	○	✓	Harvested sustainably	$B_{pa}$ , $B_{lim}$	○	○	Full reproductive capacity	Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable	Fishing mortality (F) declined from 2000 but is estimated to be above $F_{MSY}$ . Spawning-stock biomass (SSB) has increased from the historical low in 2006 to above $MSY B_{trigger}$ in 2017. There are indications of increased recruitment in 2017.	ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 59 888 tonnes.
	Fishing pressure			Status	Stock size																																								
	2014	2015	2016		2015	2016	2017																																						
Maximum sustainable yield	$F_{MSY}$	✗	✗	Above	$MSY B_{trigger}$	✗	✗	Above trigger																																					
Precautionary approach	$F_{pa}$ , $F_{lim}$	○	✓	Harvested sustainably	$B_{pa}$ , $B_{lim}$	○	○	Full reproductive capacity																																					
Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable																																					
had.27.46a20 (Haddock)	Subarea 4 (North Sea) and Divisions 7.d (Eastern Channel) and 6.a (West of Scotland)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th rowspan="2">Status</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2014</th> <th>2015</th> <th>2016</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum sustainable yield</td> <td><math>F_{MSY}</math></td> <td>✗</td> <td>✗</td> <td>Above</td> <td><math>MSY B_{trigger}</math></td> <td>✓</td> <td>✗</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary approach</td> <td><math>F_{pa}</math>, <math>F_{lim}</math></td> <td>○</td> <td>✗</td> <td>Increased risk</td> <td><math>B_{pa}</math>, <math>B_{lim}</math></td> <td>✓</td> <td>○</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> </tr> </tbody> </table>		Fishing pressure			Status	Stock size			2014	2015	2016	2015	2016	2017	Maximum sustainable yield	$F_{MSY}$	✗	✗	Above	$MSY B_{trigger}$	✓	✗	Above trigger	Precautionary approach	$F_{pa}$ , $F_{lim}$	○	✗	Increased risk	$B_{pa}$ , $B_{lim}$	✓	○	Full reproductive capacity	Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable	Fishing mortality (F) has been fluctuating above $F_{MSY}$ for most of the time series and is above $F_{MSY}$ in 2016. Spawning-stock biomass (SSB) has been mostly above $MSY B_{trigger}$ since 2002. Recruitment since 2000 has been characterized by a low average level with occasional larger year classes, the size of which is diminishing. The 2014 recruitment estimate is higher than recent low recruitment, but is still below the long-term average.	ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 50 056 tonnes.
	Fishing pressure			Status	Stock size																																								
	2014	2015	2016		2015	2016	2017																																						
Maximum sustainable yield	$F_{MSY}$	✗	✗	Above	$MSY B_{trigger}$	✓	✗	Above trigger																																					
Precautionary approach	$F_{pa}$ , $F_{lim}$	○	✗	Increased risk	$B_{pa}$ , $B_{lim}$	✓	○	Full reproductive capacity																																					
Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable																																					
ple.27.420 (Plaice)	Subarea 4 (North Sea) and Division 3.a West (Skagerrak)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th rowspan="2">Status</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2014</th> <th>2015</th> <th>2016</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum Sustainable Yield</td> <td><math>F_{MSY}</math></td> <td>✓</td> <td>✓</td> <td>Below</td> <td><math>MSY B_{trigger}</math></td> <td>✓</td> <td>✓</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary Approach</td> <td><math>F_{pa}</math>, <math>F_{lim}</math></td> <td>✓</td> <td>✓</td> <td>Harvested sustainably</td> <td><math>B_{pa}</math>, <math>B_{lim}</math></td> <td>✓</td> <td>✓</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> </tr> </tbody> </table>		Fishing pressure			Status	Stock size			2014	2015	2016	2015	2016	2017	Maximum Sustainable Yield	$F_{MSY}$	✓	✓	Below	$MSY B_{trigger}$	✓	✓	Above trigger	Precautionary Approach	$F_{pa}$ , $F_{lim}$	✓	✓	Harvested sustainably	$B_{pa}$ , $B_{lim}$	✓	✓	Full reproductive capacity	Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable	The spawning stock biomass (SSB) is well above $MSY B_{trigger}$ , and has markedly increased in the past ten years. Recruitment has been around the long-term average since the mid-1990s. Since 2009, fishing mortality (F) has been estimated at around $F_{MSY}$ .	ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 134 238 tonnes.
	Fishing pressure			Status	Stock size																																								
	2014	2015	2016		2015	2016	2017																																						
Maximum Sustainable Yield	$F_{MSY}$	✓	✓	Below	$MSY B_{trigger}$	✓	✓	Above trigger																																					
Precautionary Approach	$F_{pa}$ , $F_{lim}$	✓	✓	Harvested sustainably	$B_{pa}$ , $B_{lim}$	✓	✓	Full reproductive capacity																																					
Management plan	$F_{MGT}$	—	—	Not applicable	$B_{MGT}$	—	—	Not applicable																																					

SPECIES	AREA	STOCK STATUS						SUMMARY	ADVICE 2018																																														
sol.27.4 (Sole)	Subarea 4 (North Sea)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2014</th> <th>2015</th> <th>2016</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum Sustainable Yield</td> <td><math>F_{MSY}</math></td> <td>✗</td> <td>✗</td> <td>✗</td> <td>Above</td> <td>MSY</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary Approach</td> <td><math>F_{pa}</math> <math>F_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Harvested sustainably</td> <td><math>B_{pa}</math> <math>B_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>✗</td> <td>✗</td> <td>✗</td> <td>Above</td> <td><math>B_{MGT}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Above</td> </tr> </tbody> </table>							Fishing pressure			Stock size			2014	2015	2016	2015	2016	2017	Maximum Sustainable Yield	$F_{MSY}$	✗	✗	✗	Above	MSY	✓	✓	✓	Above trigger	Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity	Management plan	$F_{MGT}$	✗	✗	✗	Above	$B_{MGT}$	✓	✓	✓	Above	<p>The spawning-stock biomass (SSB) has increased since 2007 and has been estimated at above MSY <math>B_{trigger}</math> since 2012. Fishing mortality (F) has declined since 1997 and is slightly above <math>F_{MSY}</math> in 2016. Recruitment (R) has fluctuated below average without trend since the early 1990s.</p>	<p>ICES advises that when the second stage of the EU management plan (Council Regulation No. 676/2007) is applied, catches in 2018 should be no more than 14 900 tonnes.</p>
	Fishing pressure			Stock size																																																			
	2014	2015	2016	2015	2016	2017																																																	
Maximum Sustainable Yield	$F_{MSY}$	✗	✗	✗	Above	MSY	✓	✓	✓	Above trigger																																													
Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity																																													
Management plan	$F_{MGT}$	✗	✗	✗	Above	$B_{MGT}$	✓	✓	✓	Above																																													
pok.27.3a46 (Saithe)	Subarea 4 (North Sea) and Divisions 3.a (Skagerrak) and Subarea 6 (West of Scotland and Rockall)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2013</th> <th>2014</th> <th>2015</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum Sustainable Yield</td> <td><math>F_{MSY}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Below</td> <td>MSY</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary Approach</td> <td><math>F_{pa}</math> <math>F_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Harvested sustainably</td> <td><math>B_{pa}</math> <math>B_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> </tr> </tbody> </table>							Fishing pressure			Stock size			2013	2014	2015	2015	2016	2017	Maximum Sustainable Yield	$F_{MSY}$	✓	✓	✓	Below	MSY	✓	✓	✓	Above trigger	Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity	Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable	<p>Recruitment (R) has fluctuated over time and has generally been below the long-term average since 2003. Fishing mortality (F) has been below <math>F_{MSY}</math> since 2013. Spawning-stock biomass (SSB) has fluctuated without trend and has been above MSY <math>B_{trigger}</math> since 1996.</p>	<p>ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 118 460 tonnes.</p> <p>Since this stock is only partially under the EU landing obligation, ICES is not in a position to advise on landings corresponding to the advised catch.</p>
	Fishing pressure			Stock size																																																			
	2013	2014	2015	2015	2016	2017																																																	
Maximum Sustainable Yield	$F_{MSY}$	✓	✓	✓	Below	MSY	✓	✓	✓	Above trigger																																													
Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity																																													
Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable																																													
whg.27.47d (Whiting)	Subarea 4 (North Sea) and Division 7.d (Eastern Channel)	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th>2014</th> <th>2015</th> <th>2016</th> <th>2015</th> <th>2016</th> <th>2017</th> </tr> </thead> <tbody> <tr> <td>Maximum Sustainable Yield</td> <td><math>F_{MSY}</math></td> <td>✗</td> <td>✗</td> <td>✗</td> <td>Above</td> <td>MSY</td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Above trigger</td> </tr> <tr> <td>Precautionary Approach</td> <td><math>F_{pa}</math> <math>F_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Harvested sustainably</td> <td><math>B_{pa}</math> <math>B_{lim}</math></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>Full reproductive capacity</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> </tr> </tbody> </table>							Fishing pressure			Stock size			2014	2015	2016	2015	2016	2017	Maximum Sustainable Yield	$F_{MSY}$	✗	✗	✗	Above	MSY	✓	✓	✓	Above trigger	Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity	Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable	<p>Spawning-stock biomass (SSB) has fluctuated around MSY <math>B_{trigger}</math>, and is now above it. Fishing mortality (F) has been above <math>F_{MSY}</math> throughout the time-series. Since 2003 recruitment (R) has been generally lower than in previous years.</p>	<p>ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 26 804 tonnes.</p>
	Fishing pressure			Stock size																																																			
	2014	2015	2016	2015	2016	2017																																																	
Maximum Sustainable Yield	$F_{MSY}$	✗	✗	✗	Above	MSY	✓	✓	✓	Above trigger																																													
Precautionary Approach	$F_{pa}$ $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ $B_{lim}$	✓	✓	✓	Full reproductive capacity																																													
Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable																																													

SPECIES	AREA	STOCK STATUS						SUMMARY	ADVICE 2018				
sol.27.7d (Sole)	Division 7.d (Eastern Channel)	Fishing pressure			Stock size			The spawning-stock biomass (SSB) has been fluctuating between $B_{lim}$ and $MSY B_{trigger}$ . Fishing mortality (F) has been decreasing since 2014 and is below $F_{MSY}$ in 2016. Recruitment has been fluctuating without trend and was in 2012-2016 among the lowest of the time-series, with the exception of 2015.	ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 3866 tonnes.				
		Maximum sustainable yield	$F_{MSY}$	2014	2015	2016	MSY $B_{trigger}$			2015	2016	2017	
		Precautionary approach	$F_{pa}$ / $F_{lim}$	○	○	●	$B_{pa}$ / $B_{lim}$	○	○	○	Increased ri		
		Management plan	$F_{MGT}$	—	—	—	$B_{MGT}$	—	—	—	Not applical		





Table 2.3.1.2.2 Nephrops stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2017																																																	
Nephrops	Botney Gut-Silver Pit (FU 5)		The state of this stock is unknown. Preliminary stock surveys (2010 and 2012) indicate relatively high density compared to neighbouring FUs. New discard data indicate that total catch numbers are considerably higher than previously assumed, implying current harvest rates above those associated with MSY for other North Sea Nephrops stocks.	ICES advises on the basis of ICES precautionary approach that catches should be no more than 1391t. Assuming the landing obligation continues with the de minimis allowance of 6% of catch for animals below the Minimum Conservation Reference Size, this implies landings of no more than 1334 t (comprising 594t wanted and 741t previously unwanted >MCRS).																																																	
Nephrops	Farn Deeps (FU 6)	<table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th colspan="2"></th> <th>2014</th> <th>2015</th> <th>2016</th> <th>2014</th> <th>2015</th> <th>2016</th> </tr> </thead> <tbody> <tr> <td>Maximum sustainable yield</td> <td><math>F_{MSY}</math></td> <td>✘</td> <td>✘</td> <td>✘</td> <td>Above</td> <td>MSY <math>B_{trigger}</math></td> <td>✘</td> <td>✘</td> <td>✘</td> <td>Below trigger</td> </tr> <tr> <td>Precautionary approach</td> <td><math>F_{pa} \cdot F_{lim}</math></td> <td>?</td> <td>?</td> <td>?</td> <td>Undefined</td> <td><math>B_{pa} \cdot B_{lim}</math></td> <td>?</td> <td>?</td> <td>?</td> <td>Undefined</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> <td><math>B_{MGT}</math></td> <td>-</td> <td>-</td> <td>-</td> <td>Not applicable</td> </tr> </tbody> </table>			Fishing pressure			Stock size					2014	2015	2016	2014	2015	2016	Maximum sustainable yield	$F_{MSY}$	✘	✘	✘	Above	MSY $B_{trigger}$	✘	✘	✘	Below trigger	Precautionary approach	$F_{pa} \cdot F_{lim}$	?	?	?	Undefined	$B_{pa} \cdot B_{lim}$	?	?	?	Undefined	Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable	<p>Although the stock abundance index increased from 2015-2016, it has been below MSY <math>B_{trigger}</math> since 2011. Harvest rates have been above the MSY level since 2008.</p>	<p>ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should not exceed 1178 tonnes.</p> <p>In order to ensure the stock in this functional unit (FU) is exploited sustainably, management should be implemented at the functional unit level. Any substantial transfer of the current surplus fishing opportunities from other FUs to this FU could rapidly lead to over-exploitation.</p>
		Fishing pressure			Stock size																																																
		2014	2015	2016	2014	2015	2016																																														
Maximum sustainable yield	$F_{MSY}$	✘	✘	✘	Above	MSY $B_{trigger}$	✘	✘	✘	Below trigger																																											
Precautionary approach	$F_{pa} \cdot F_{lim}$	?	?	?	Undefined	$B_{pa} \cdot B_{lim}$	?	?	?	Undefined																																											
Management plan	$F_{MGT}$	-	-	-	Not applicable	$B_{MGT}$	-	-	-	Not applicable																																											


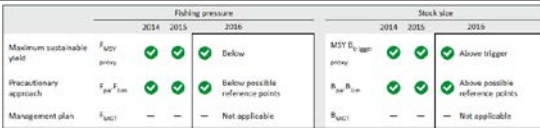
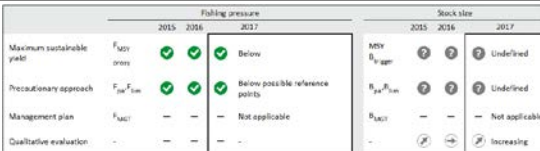
SPECIES	AREA	STOCK STATUS						SUMMARY	ADVICE 2017				
		Fishing pressure			Stock size								
		2014	2015	2016	2014	2015	2016						
Nephrops	Fladen Ground (FU 7)	Maximum sustainable yield	$F_{MSY}$	✓	✓	✓	Below	MSY	✓	✗	✓	Above trigger	<p>The stock size declined from the highest observed value in 2008 to the lowest abundance estimate in the time-series in 2015. In 2016 the stock size increased and is now above MSY <math>B_{trigger}</math>. The harvest rate has declined since 2010 and remains well below <math>F_{MSY}</math>.</p> <p>ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should not exceed 13264 tonnes.</p> <p>In order to ensure the stock in this functional unit (FU) is exploited sustainably, management should be implemented at the FU level. In recent years, the catch in this FU has been lower than advised, and if the difference is transferred to other FUs, this could result in non-precautionary exploitation of those FUs.</p>
		Precautionary approach	$F_{pa}$ / $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ / $B_{lim}$	✓	✗	✓	Full reproductive capacity	
		Management plan	$F_{MGT}$	—	—	—	Not applicable	$B_{MGT}$	—	—	—	Not applicable	
Nephrops	Firth of Forth (FU 8)	Maximum sustainable yield	$F_{MSY}$	✗	✗	✓	Below	MSY	✓	✓	✓	Above trigger	<p>The stock size has been above MSY <math>B_{trigger}</math> for most of the time series. The harvest rate is varying and is now below <math>F_{MSY}</math>.</p> <p>ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should not exceed 2826 tonnes.</p> <p>In order to ensure the stock in this functional unit (FU) is exploited sustainably, management should be implemented at the FU level. In recent years, the catch in this FU has been lower than advised, and if the difference is transferred to other FUs, this could result in non-precautionary exploitation of those FUs.</p>
		Precautionary approach	$F_{pa}$ / $F_{lim}$	?	?	✓	Below possible reference points	$B_{pa}$ / $B_{lim}$	✓	✓	✓	Above possible reference points	
		Management plan	$F_{MGT}$	—	—	—	Not applicable	$B_{MGT}$	—	—	—	Not applicable	

SPECIES	AREA	STOCK STATUS						SUMMARY	ADVICE 2017
Nephrops	Moray Firth (FU 9)	Fishing pressure			Stock size			<p>The stock has been above <math>MSY B_{trigger}</math> for the entire time series. The harvest rate has fluctuated around <math>F_{MSY}</math> and is now just above.</p>	<p>ICES advises that when the MSY approach is applied, and assuming that discard rates and fishery selection patterns do not change from the average of 2014–2016, catches in 2018 should not exceed 1219 tonnes.</p> <p>In order to ensure the stock in this functional unit (FU) is exploited sustainably, management should be implemented at the FU level. In recent years, the catch in this FU has been lower than advised, and if the difference is transferred to other FUs, this could result in non-precautionary exploitation of those FUs.</p>
		Maximum sustainable yield	$F_{MSY}$	2014:  2015:  2016:  Above	$MSY B_{trigger}$	2014:  2015:  2016:  Above trigger			
		Precautionary approach	$F_{pa} F_{lim}$	2014:  2015:  2016:  Undefined	$B_{pa} B_{lim}$	2014:  2015:  2016:  Undefined			
		Management plan	$F_{MGT}$	2014: - 2015: - 2016: - Not applicable	$B_{MGT}$	2014: - 2015: - 2016: - Not applicable			
Nephrops	Noup (FU 10)	<p>The state of the stock is unknown. UWTV surveys in FU 10 have been conducted sporadically and indicated that the density is relatively low (0.13 Nephrops <math>m^{-2}</math>). Landings in FU 10 are at a historical minimum, suggesting harvest rates below those associated with MSY for other North Sea Nephrops stocks.</p>						<p>ICES advises on the basis of ICES approach to data-limited stocks that catches should be no more than 40 t. If discard patterns do not change from the assumed rate and assuming the landing obligation continues with the de minimis allowance of 6% of catch for animals below the Minimum Conservation Reference Size, this implies landings of no more than 38 t.</p>	

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2017
Nephrops	Norwegian Deep (FU 32)		<p>The state of this stock is unknown. Harvest ratios are thought to be low for this stock even if a low density is assumed (e.g., the lowest observed density in the North Sea is in FU 7, Fladen Ground). Catches have been decreasing since 2006. The Danish fishery has contracted into the southernmost part of the functional unit where a decreasing Danish <i>lpue</i> indicates that fishing pressure may be increasing.</p>	<p>ICES advises that when the precautionary approach is applied, catches in 2017 (assuming a landing obligation applies) should be no more than 496 tonnes. If this stock is not under the EU landing obligation in 2017 and discard rates do not change from the average of the period 2006–2015, this implies landings of no more than 464 tonnes.</p>
Nephrops	Horn's Reef (FU 33)			

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2017
Nephrops	Devil's Hole (FU 34)		<p>The state of this stock is unknown. Harvest rates are thought to be low for this stock even if a low density is assumed (e.g., the lowest observed density in the North Sea is in FU 7, Fladen Ground). Catches have been relatively stable since 2004, fluctuating without trend around 1000 tonnes.</p>	<p>ICES advises on the basis of ICES approach to data-limited stocks that catches should be no more than 1257 t. If discard patterns do not change from the observed rate (2015) and assuming the landing obligation continues with the de minimis allowance of 6% of catch for animals below the Minimum Conservation Reference Size, this implies landings of no more than 1257 t.</p>

Table 2.3.1.2.3 Ancillary stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2017																																																		
bl.27.3a47d (Brill)	Subarea 4 (North Sea) and Divisions 3.a (Skagerrak), 7.d and 7.e (English Channel)	 <table border="1"> <thead> <tr> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th></th> <th>2014</th> <th>2015</th> <th>2016</th> <th></th> <th>2014</th> <th>2015</th> <th>2016</th> </tr> </thead> <tbody> <tr> <td>Maximum sustainable yield</td> <td><math>F_{MSY}</math></td> <td><math>F_{MSY}</math></td> <td><math>F_{MSY}</math></td> <td>Below</td> <td><math>MSY B_{trigger}</math></td> <td><math>MSY B_{trigger}</math></td> <td><math>MSY B_{trigger}</math></td> <td>Above</td> </tr> <tr> <td>Precautionary approach</td> <td><math>F_{pa}</math></td> <td><math>F_{pa}</math></td> <td><math>F_{pa}</math></td> <td>Below possible reference points</td> <td><math>B_{pa}</math></td> <td><math>B_{pa}</math></td> <td><math>B_{pa}</math></td> <td>Above possible reference points</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MCP}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> <td><math>B_{MCP}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> </tr> <tr> <td>Qualitative evaluation</td> <td>—</td> <td>—</td> <td>—</td> <td>—</td> <td>—</td> <td>—</td> <td>—</td> <td>—</td> </tr> </tbody> </table>	Fishing pressure			Stock size				2014	2015	2016		2014	2015	2016	Maximum sustainable yield	$F_{MSY}$	$F_{MSY}$	$F_{MSY}$	Below	$MSY B_{trigger}$	$MSY B_{trigger}$	$MSY B_{trigger}$	Above	Precautionary approach	$F_{pa}$	$F_{pa}$	$F_{pa}$	Below possible reference points	$B_{pa}$	$B_{pa}$	$B_{pa}$	Above possible reference points	Management plan	$F_{MCP}$	—	—	Not applicable	$B_{MCP}$	—	—	Not applicable	Qualitative evaluation	—	—	—	—	—	—	—	—	The biomass index has been gradually increasing over the time-series with moderate interannual variability. The last two years are higher than the three previous years.	ICES advises that when the precautionary approach is applied, catches should be no more than 3170 tonnes in each of the years 2018 and 2019. If discard rates do not change from the average of the last 3 years (2014–2016), this implies landings of no more than 2943 t.
Fishing pressure			Stock size																																																			
	2014	2015	2016		2014	2015	2016																																															
Maximum sustainable yield	$F_{MSY}$	$F_{MSY}$	$F_{MSY}$	Below	$MSY B_{trigger}$	$MSY B_{trigger}$	$MSY B_{trigger}$	Above																																														
Precautionary approach	$F_{pa}$	$F_{pa}$	$F_{pa}$	Below possible reference points	$B_{pa}$	$B_{pa}$	$B_{pa}$	Above possible reference points																																														
Management plan	$F_{MCP}$	—	—	Not applicable	$B_{MCP}$	—	—	Not applicable																																														
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dab.27.3a4 (Dab)	Subarea 4 (North Sea) and Division 3.a (Skagerrak)	 <table border="1"> <thead> <tr> <th colspan="3">Fishing pressure</th> <th colspan="3">Stock size</th> </tr> <tr> <th></th> <th>2014</th> <th>2015</th> <th>2016</th> <th></th> <th>2014</th> <th>2015</th> <th>2016</th> </tr> </thead> <tbody> <tr> <td>Maximum sustainable yield</td> <td><math>F_{MSY}</math></td> <td><math>F_{MSY}</math></td> <td><math>F_{MSY}</math></td> <td>Below</td> <td><math>MSY B_{trigger}</math></td> <td><math>MSY B_{trigger}</math></td> <td><math>MSY B_{trigger}</math></td> <td>Above trigger</td> </tr> <tr> <td>Precautionary approach</td> <td><math>F_{pa}</math></td> <td><math>F_{pa}</math></td> <td><math>F_{pa}</math></td> <td>Below possible reference points</td> <td><math>B_{pa}</math></td> <td><math>B_{pa}</math></td> <td><math>B_{pa}</math></td> <td>Above possible reference points</td> </tr> <tr> <td>Management plan</td> <td><math>F_{MCP}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> <td><math>B_{MCP}</math></td> <td>—</td> <td>—</td> <td>Not applicable</td> </tr> </tbody> </table>	Fishing pressure			Stock size				2014	2015	2016		2014	2015	2016	Maximum sustainable yield	$F_{MSY}$	$F_{MSY}$	$F_{MSY}$	Below	$MSY B_{trigger}$	$MSY B_{trigger}$	$MSY B_{trigger}$	Above trigger	Precautionary approach	$F_{pa}$	$F_{pa}$	$F_{pa}$	Below possible reference points	$B_{pa}$	$B_{pa}$	$B_{pa}$	Above possible reference points	Management plan	$F_{MCP}$	—	—	Not applicable	$B_{MCP}$	—	—	Not applicable	The assessment is indicative of trends only. The biomass (SSB) has been increasing since 2006. Total mortality (Z) has declined since 2003. The recruitment (R) shows an increasing trend until 2014 but declined for the recent two years of the time-series.	ICES advises that when the precautionary approach is applied, catches in 2018 and 2019 should be no more than 64452 tonnes. If discard rates do not change from the average of the last 3 years (2014–2016), this implies landings of no more than 6116 tonnes.									
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Fishing pressure			Stock size																																																			
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Qualitative evaluation	—	—	—	—	—	—	—	Increasing																																														
tur.27.4 (Turbot)	Subarea 4 (North Sea)	Not available																																																				

## 2.4 Fleets and métiers

### 2.4.1 Catch and effort Data

Prior to 2012, catch (landings and discards) and effort data were submitted to WGMIXFISH as comma separated files structured around the distinction of gear, mesh size and vessel length categories (based to a large extent on the format used by the STECF for the evaluation of effort management). From 2012 to 2014 a joint WGNSSK/WGMIXFISH data call has been issued, with age and discards data by métier (consistent with the DCF definition of métiers) to be submitted to InterCatch, and landings and effort data by métier and vessel length class to be submitted as .csv files. From 2015, ICES generalized the data call to most stocks and regions. The process and the quality of data have thus continuously improved over time.

In 2017, InterCatch data were extracted for the longest time series possible, on the basis that most North Sea demersal stocks have been benchmarked in the recent years, and thus have updated catch-at-age information starting in 2004. Nevertheless, it was realized that this information prior to 2009 is still incomplete for some stocks, the reasons for these were not investigated. Consequently, the data presented here cover only the time period 2009–2016.

Noticeably, although the data collation process is somehow smoother, it remains a very tedious and time-demanding work. The processes developed to automatize the various steps of merging different data sets from different countries and different data sources together have also increased the amount of checks and graphical visualization of the data using e.g. some R shiny apps. Thus, in 2017, substantial amount of time was still dedicated during the WG to understand and correct a number of data mismatches which had not been detected in previous years.

The relative size of catches of the stocks incorporated in the mixed fisheries projections is shown in Figure 2.4.1.

Despite the data now being available according to DCF categorization, WGMIXFISH was of the opinion to continue using the categorization following the EU Cod management plan as used in previous years, both in order to maintain the consistency of the MIXFISH time-series and in order to continue addressing management-oriented scenarios and issues. WGMIXFISH métiers are thus defined as combinations of gear, mesh size and area (North Sea (area 4), Skagerrak (area 3AN) or Eastern Channel (area 7D)).

The consistency between DCF and EU Cod plan categories had been investigated by WGMIXFISH 2011 and during the pilot data call performed in autumn 2011. There it had been shown that most DCF métiers as sampled by individual nations could automatically be allocated to a corresponding EU Cod plan métier, with two exceptions: the TBB\_DEF\_70–99\_0\_0 métier in the North Sea (as the corresponding BT2 métier is only defined for the mesh sizes 80–99) and the OTB\_DEF (or CRU)\_90–119\_0\_0 métier in the Skagerrak, which straddles over the TR1 ( $\geq 100$  mm) and TR2 (70–99 mm) categories. As in previous years, the TBB\_DEF\_70–99\_0\_0 métier was assumed equivalent to BT2, and the Skagerrak 90–119\_0\_0 was assumed as TR2, to maintain consistency with previous data. Since 2012 the Swedish *Nephrops* fishery with an escapement grid, OTB\_CRU\_70–89\_2\_35 has been kept distinct from the other DCF métiers.

The final dataset extracted from InterCatch for use by WGNSSK includes discards estimates (either imported or raised) for all stocks and métiers. These InterCatch estimates have been used to estimate a discard ratio by métier, which allows allocating discards for all WGMIXFISH fleets and métiers with matching names, such that;

$$d^* = \frac{DI}{L}$$

Where  $d^*$  is the discard value for the métier used by Fcube,  $I$  is the weight of landings for the métier used by Fcube and  $L$  and  $D$  are the weights of landings and discards entered for the (vessel length aggregated) métier in InterCatch.

#### 2.4.2 Definitions of fleets and métiers

The procedure for establishing fleets and métiers was not revised in 2017, and has therefore been the same since 2012. Nevertheless, as the procedure is applied to the last data year, the number of fleets and métiers can vary slightly from one WGMIXFISH report to the next.

In summary, the procedure follows a number of steps:

- Matching DCF métiers with definitions used in the cod long-term management plan
- Establishing fleets by country, gear type and, when deemed necessary, vessel length group
- Matching consistency between effort and catch data files. Métiers without catch of any of the modelled stocks in the last data year (now 2016) are not retained.
- Aggregating “small” métiers to reduce the number of units in the modeling. A métier failing to catch at least 1.0% of at least one of the stocks considered in the most recent data year is classified as small. Within each fleet, all these small métiers are then aggregated by fleet in one “Other” métier (OTH). Further, all small fleets (i.e. containing only the “OTH” métier), are aggregated into one single “OTH” fleet.

In 2017, the final data used contained 42 national fleets (plus the OTH fleet). These fleets engage in one to five different métiers each, resulting in 105 combinations of country\*fleet\*métier\*area catching cod, haddock, whiting, saithe, plaice, sole and *Nephrops* (Table 2.4.2.a). The balance of landings of the stocks across gear categories is shown in Figure 2.4.2.a.

As a cross check of the data the total landings and discards across all fleets was compared to the values estimated from the single species stock assessments. Some landings may not be allocated to fleets, due to for example missing countries or areas (e.g. area 6.a for saithe and haddock) or national landings with missing logbook information that cannot be allocated to a fleet. The landings coverage for all fish stocks is very high (between 90 and 100% of landings of each fish stock could be allocated to one of the fleets) but more variable for the *Nephrops* stocks (between 69 and 100%). To address the remaining small inconsistencies between fleet data used by WGMIXFISH and stock data, the differences between them were pooled into the “OTH” fleet (both landings and discards).

#### 2.4.3 Trends

A number of overview graphs (using the Lattice and ggplot package in R) were produced to aid quality checking of the data once compiled into the final fleets object. Some are useful to show the relative importance of the fleets chosen and trends in their effort and catches. Effort by fleet in absolute levels (Figure 2.4.3.a) and relative trends (Figure 2.4.3.b), effort share by métier and fleet (Figure 2.4.3.c) and landings by fleet and stock (Figure 2.4.3.d) are included in this report.



## 2.5 Mixed fisheries forecasts

### 2.5.1 Description of scenarios

#### 2.5.1.1 Baseline Runs

The objectives of the single species stock baseline runs were to reproduce as closely as possible the single species advice produced by ACOM, and act as the reference scenario for subsequent mixed fisheries analyses.

The various single stock forecasts presented by WGNSSK are performed using different software and setups (see 2.2 above). However, for the purpose of the mixed-fisheries analyses, it is necessary to gather all forecasts into a single unified framework, which builds on the 'fwd()' method in FLR (Flash R add-on package). The same forecast settings as in WGNSSK are used for each stock regarding weight-at-age, selectivity and recruitment, as well as assumptions on the  $F$  in the intermediate year and basis for advice (LTMP or MSY approach).

Some differences can occur in the forecast calculations, (sometimes because of the diversity of single stock assessment methods used) and the WG always investigates in depth the reasons for potential discrepancies. Adjustments to the Fcube forecasts are made if necessary to minimize discrepancies to the largest extent possible.

The intention of the baseline runs was thus mainly to act as a check to ensure that the projections were set up correctly within the Fcube script, but these runs also have the incidental benefit of acting as a quality control check on the WGNSSK projections themselves.

#### 2.5.1.2 Mixed fisheries runs

Prior to 2013, projections were run applying the Fcube scenarios two years in a row, i.e. both for the intermediate year and the TAC year. This allowed WGMIXFISH to analyse why management plans often did not deliver their expected results and why some short-term forecasts had been overoptimistic in the past (see Kraak *et al.*, 2013), by evaluating the impact of the assumptions in the intermediate year.

However, since 2013, the working group adopted a forecast approach for the intermediate year on the basis of *Status quo* effort. As a roll-over of effort limitations from the cod management plan has been adopted by the EC since 2013, a *status quo* effort assumption is considered a plausible assumption and is more in line with the standard single stock short-term forecasting approach (which apply a *status quo*  $F$ , unless a TAC constraint is used). The 2018 single stock advice for haddock and saithe assume that the 2017 TAC will be fully utilised. However, this implies a reduction of 35% of the fishing mortality for haddock in 2017 compared to 2016, and conversely an increase of 39% for saithe. These opposite directions will have implications for the mixed fisheries in 2017, and it can therefore not be assumed, as usually done in the mixed-fisheries projections, that effort in 2017 will be similar to that of 2016. Consequently, the projections in the scenarios "Min", "Max" and "Val" assume that the "Val" scenario is applied in 2017, which means that the saithe-targeting fleets are assumed to increase their effort in 2017 in the model, while the haddock-targeting fleets are assumed to decrease their effort.

An important change was brought to the projections in 2015, linked to the incoming implementation of the landings obligation. Historically, the mixed fisheries projections

have been presented in terms of landings and overshoots or undershoots of the retained portion of the catch, assuming fishing fleets would discard as observed in past years and that only the landings counted against the fleets' stock shares.

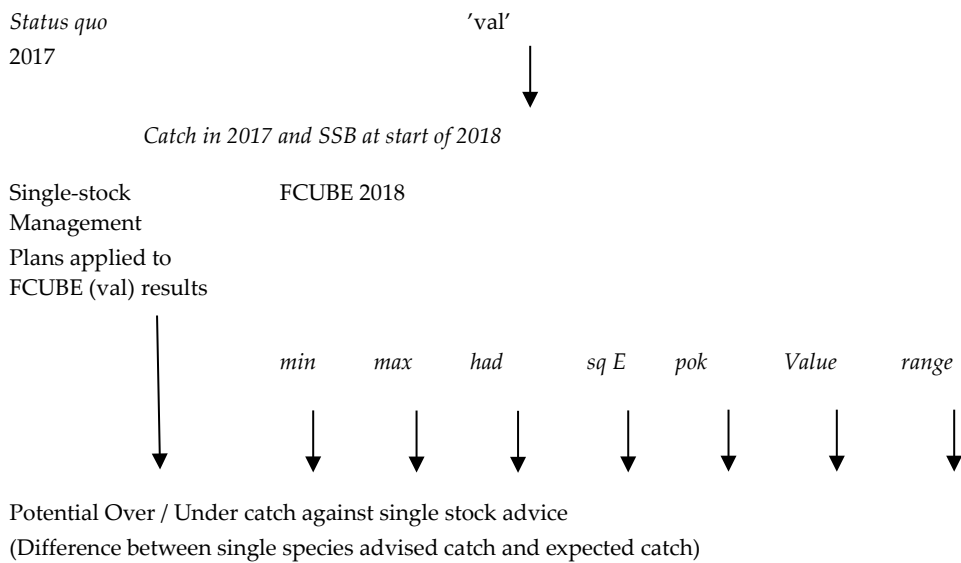
This year, the projections were run assuming a full and perfect implementation of a discard ban in 2017 (i.e. all quota species caught must be landed, with no exemptions, *de minimis* or inter-species flexibilities) for species under Landing Obligation (i.e. Haddock, Sole and *Nephrops*, for *Nephrops* a 6% *de minimis* is assumed). The TAC was lifted up with the 2016 discards estimates for these species and all catches are assumed to be landed and to count against the quota.

While WGMIXFISH was aware that the landings obligation may not be implemented for all stocks in 2018, and that discards will not disappear overnight, it was considered that this option would bring new insights to where the choke effects will lie. The main implication of this change in the results would be that stocks for which some fleets had high discards in the past may become more limiting for those fleets, due to the mismatch between their catches (which now all count against the fleets' stock shares) and their stock shares based on historical landings.

In summary, the Fcube runs followed the scheme below:

Single-stock assessment 2017 (data up to 2016)

Management Plan/ MSY approach



## 2.5.2 Results of Fcube runs

### 2.5.2.1 Baseline run

The rationale behind the single species baseline runs is given in Section 2.3.1.2. Table 2.5.2.1.a contains the outputs from these runs.

The Figure 2.5.2.1.a summarises the trends arising from the various single-stocks advice for finfish for 2018, displaying at once which stocks have an advice expecting a reduction in F (and thus in effort) and which have an expected increase. Whiting and haddock are likely to be the most limiting finfish stocks.

The issues and problems encountered in replicating the single species advice for each species are given below. The results from these baseline runs are compared with the

results from the corresponding ICES runs in Tables 2.5.2.1.b and 2.5.2.1.c, and summarized at Figure 2.5.2.1.b.

**Cod:** The North Sea cod assessment and forecast was based on the SAM assessment package and this had important consequences for the WG's ability to reproduce it in Fcube. The cod forecast in WGNSSK is stochastic, produced internally in SAM by generating 1000 stochastic replicates drawn within the confidence interval of the F-at-age, N-at-age and Catch multiplier estimates, while the WGMIXFISH forecast is only a deterministic projection. As the median of the forecasted assessment may be slightly different from the forecast of the median assessment, small discrepancies may appear. Additionally, the SAM model has a process error (deviations of N-at-age from the survival equation) which is carried on into the forecast. The projections carried out in SAM do not follow equation used in the deterministic forecast carried out at WGMIXFISH, which also generate differences between the two forecasts.

In 2017, the F assumption in the intermediate year was made using the 'value' scenario on the basis that the intermediate year assumption for saithe and haddock (TAC constraint) implies incompatible effort levels for both stocks (the 2017 TAC for Northern Shelf haddock is highly restrictive while the 2017 TAC for saithe can support an increase of fishing mortality for that stock). For the TAC year, ICES decided to use the MSY strategy as the basis for advice, instead of the management plan, which is not considered precautionary and appropriate anymore after the important changes in the stock's dynamics and in the reference points following the 2015 benchmark and WGNSSK.

Some small differences were observed (-3.8% and -2.7% in the estimated catches in 2017 and 2018 respectively and -3.7% difference in SSB in 2019). Nevertheless, the Fcube forecast was considered sufficiently close that it could be used as a satisfactory basis for the mixed-fisheries projection.

**Haddock:** In 2015 the haddock assessment used TSA as the assessment basis and MDFP as the forecasting software. The method developed in WGNSSK to parameterize future selectivity and weight-at-age for haddock are sometimes quite specific and do not always follow common standards (e.g. weights-at-age in the forecasted period produced by a growth model instead of the commonly used assumption of constant weights equal to the average over the recent years). Those specific values could not be reproduced in the forecasting procedure of Fcube and were therefore entered manually.

In addition, the survivors at the start of 2017 produced by the TSA assessment model used as the initial abundance-at-age in the MFDP short-term forecast were slightly different from the initial numbers at age computed by the forecasting procedure in FLR.

The forecast results were slightly different with a -0.2% and -0.1% discrepancy between SSB projections in 2018 and 2019 respectively. Forecasted catches in 2017 and 2018 showed a 0.1% and 0.5% difference respectively. The FLR forecast was considered sufficiently close for use in the mixed-fisheries projection.

**Whiting:** The WGNSSK forecast treats the industrial bycatch separately from the landings for human consumption, with specific future weights-at-age and selectivity. The Fcube forecast used at WGMIXFISH did not allow for multiple fleets and therefore the industrial bycatch is included in the landings component. The future landings selectivity and weights-at-age were recalculated as the weighted means of the values in the landings for human consumption and industrial by catch.

This difference in forecast procedure resulted in small discrepancies in the output with differences in catches of 1.4% and 3.3% for 2017 and 2018 respectively, and of 0.1% and 0.2% in 2018 and 2018 respectively for the SSB.

**Saithe:** As for cod, the 2016 saithe assessment and forecast were carried out using the SAM assessment model. The difference in forecast procedure compare to WGMIXFISH resulted in differences in the output of 2.4% in the Fbar value for 2017, 3.1% in the 2019 catches and 4.3 % in the 2019 SSB. The FLR forecast was considered sufficiently close for use in the mixed-fisheries projection.

**North Sea Plaice:** Straightforward, no problems encountered.

**English Channel Plaice:** Significant migrations of plaice occur between the North Sea, Eastern Channel and Western Channel. As a result, the only a proportion of the plaice TAC defined in sub division 7.d corresponds to the Eastern Channel plaice. The forecast takes account of the expected quantity of plaice caught in the eastern channel adjusting for these migrations.

The results from the Fcube forecast were identical to the results from WGNSSK.

**North Sea Sole:** Straightforward, no problems encountered.

**English Channel Sole:** Straightforward, no problems encountered.

**Nephrops:** The forecasts applied the recommended harvest rates to the most recent abundance estimates available for the relevant FUs (FU 6, 7, 8, and 9). The ICES advice for 2017 is given assuming that the landing obligation is applied in 2017 for all FUs (except the FU32), with a 6% *de minimis* exception for the *Nephrops* below the Minimum Conservation Reference Size. In addition, the survival rate of the discards below the MCRS is also taken into account in the ICES advice.

The WGNSSK procedure was reproduced as closely as possible in Fcube. Nevertheless, some small discrepancies were found, with differences up to 9.5% in the forecasted 2018 landings.

It should be noted, that in the mixed fisheries forecasts *Nephrops* are treated slightly differently to the approach taken by WGNSSK. The following two changes are made:

First, there is a difference in the assumed harvest ratio in the intermediate year. Whereas WGNSSK assumes that the harvest ratio is equivalent to the average ratio of the most recent three years, the WGMIXFISH value is based on a share of the 2016 TAC applied to the abundance estimates in 2016 for that particular FU (equal to proportion of the North Sea TAC that was taken from the FU in the most recent year). This can cause pronounced differences if the harvest ratio has a steep decrease or increase in the most recent year. The assumption taken in WGMIXFISH may be more appropriate, as it is quicker to react to changes in biomass or exploitation patterns where activity moves between FUs; however, it has no consequence either for WGNSSK or WGMIXFISH TAC year harvest ratio or TAC advice as the harvest ratio in 2016 is not used in the forecasts for 2017.

Second, the TAC result for FUs may be different between WGNSSK and WGMIXFISH. This results because the TAC advice from the single species assessments is an advised landing per FU. However, because management is currently by a combined TAC, not FU, WGMIXFISH assumes that the total TAC is taken in proportion to the ratio of last year's landings by FU, distributing the landings differently to the advice. Such an approach assumes the same catchability as last year, as for other stocks in the Fcube simulations.

### 2.5.2.2 Mixed fisheries analyses

The full overview of the Fcube projections to 2018 is presented in Table 2.5.2.2.a and Figures 2.5.2.2.a – 2.5.2.2.c. The results for 2018 can be compared to each other as in a single-species option table. For ease of comparison, it was decided to also include a table with the landings relative to the single stock advice. This is presented as Table 2.5.2.2.c.

The outcomes of the “minimum” and “maximum” scenarios are driven by which of the stocks will be most and least limiting for each individual fleet. As in 2016, cod was not estimated to be the most limiting stock in the “Minimum” scenario. For 2018, assuming a strictly implemented landings obligation (i.e. a discard ban where all catches of quota species must be counted against quota, with no flexibilities such as exemptions, *de minimis* allowed discards or inter-species flexibility, as the “Minimum” scenario represents), haddock, whiting, and to a lesser extent Norway lobster in FU 6 would be the most limiting stocks, constraining 24, 8 and 10 of the 42 fleet segments, respectively.

Conversely, in the “Maximum” scenario, if *Nephrops* was managed by separate TACs for the individual functional units (FU), many *Nephrops* FU would be considered as being the least limiting stocks. *Nephrops* FU 7, FU 5, FU 33 and FU Others would be least limiting for fleets representing to 9, 2, 1 and 1 of the fleets segments. The “Minimum” scenario assumes that fleets would stop fishing when their first quota share is exhausted, regardless of the actual importance of this quota share, thus leading to a distorted perception of plausible fleet behaviour. 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.

In contrast to the “Minimum” scenario, the “Maximum” scenario demonstrates the upper bound of potential fleet effort and stock catches. However, through assuming all fleets continue fishing until all their quotas are exhausted irrespective of the economic viability of such actions, this is also considered a scenario with low plausibility.

Five intermediate scenarios are included reflecting current management measures, and also the *status quo* option. 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 would need 100 days fishing for catching its share of stock A, and 200 days fishing for catching its share of stock B, and if the value (tonnage × mean price in 2014) 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 2016, 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 other scenarios (Ulrich *et al.*, 2011). In this scenario, some overshoot of cod, whiting, and sole, and undershoot of plaice and haddock fishing opportunities are predicted.

The “POK”, “HAD” scenario reflects the fishing mortality corresponding to the single stock advice for respectively saithe and Haddock (based on the ICES MSY approach), and the results present fishing opportunities for other stocks in a mixed-fisheries context. According to the single stock advice, a reduction of 6% in saithe F is required (from 0.38 in 2017 to 0.36 in 2018) and an increase of 6% in haddock F is required (from 0.183 to 0.194 in 2018). In these scenarios it is assumed that effort reductions in fleets (to achieve new partial Fs) apply equally to all fleets with any haddock or saithe catch respectively, including those where it represents a small bycatch component. Similar scenarios based on the single stock advice for the other finfish stocks could be provided

by ICES, but the “Haddock” and “Saithe” scenarios are considered here because saithe and haddock are assumed to be the limiting species

The stocks of sole and plaice in the Eastern English Channel have low landings compared to other stocks and the results for these stocks are presented in detail in Figure 2.5.2.2.

Mixed-fisheries results for *Nephrops* are displayed after combining over functional units (FUs) in plots, but stock status and fishing opportunities differ widely across FUs. In particular, FU6 (Farn Deep) is currently exploited over the MSY target, and this FU acts therefore as a limiting stock for some fleets in the mixed-fisheries advice 2017. Conversely, FU7 (Fladen Ground) is exploited well below the MSY target, and acts as a least limiting stock. In order to ensure *Nephrops* stocks are exploited sustainably in the different FUs, management should therefore be implemented at the FU level. Potential undershoot of catch opportunities for FU7 should not be transferred to other FUs.

To get an overview of the amount of total catches for the various scenarios, Figure 2.5.2.2.a displays the catch by scenario for each of the species. Potential overshoot/undershoot on this figure are calculated by comparing the single species catch advice for 2017 with the mixed-fisheries catch estimates.

The anticipated SSBs in 2019 of the Fcube scenarios are shown in Figure 2.5.2.2.c.

Figures 2.5.2.2.d and 2.5.2.2.e show the level of effort required by each fleet to catch their quota share of the single species TAC advice for each stock for finfish species and *Nephrops* FUs respectively. From Figure 2.5.2.2.d it is clear whiting and haddock are the limiting species for many of the fleets.

#### 2.5.2.2.1 Optimised range option

A “range” scenario is presented (Figures 2.5.2.2.1.1 and 2.5.2.2.1.2), where the potential TAC mismatch in 2018 are minimised by setting target fishing levels within the  $F_{MSY}$  ranges. This scenario returns a fishing mortality by stock which, if used for setting single stock fishing opportunities for 2018, may reduce the gap between the most and the least restrictive TACs, thus reducing the potential for quota over- and undershoot. This “range” scenario suggests that the potential for mixed-fisheries mismatch would be lowered with a 2018 TAC in the lower part of the  $F_{MSY}$  range for eastern Channel plaice and saithe, and in the upper part of the range for cod and North Sea plaice.

#### 2.5.2.2.2 Relative stability

Relative stability as such is not directly included as an input to the model. Instead, an assumption that the relative landings share of the fleets are constant is used as a proxy, and in the scenarios above, this input is calculated as the average landing share by fleet and stock in 2016. In previous years, the landings by national fleets were summed over nation for each scenario, and the share by country was compared with this initial input. The results showed only minor deviations across all scenarios, except for the **Ef\_Mgt** scenario. This year, as total catches are used rather than landings, some distortions occur, as the proportion of catches does not reflect the proportion of landings since discards rates differ across fleets (Figure 2.5.2.2.2). This illustrates some of issues that will arise with the implementation of the landings obligation.

**Table 2.2.1 Summary of the 2017 fleet data submitted to WGMIXFISH compared with the WG data as submitted to WGNSSK**

year	stock	WG,land	WG,disc	ratio,l	ratio,d
2016	COD-NS	38104	12203	1,02	0,9
2016	HAD	35060	7756	1,01	0,96
2016	COD-NS	38104	12203	1,02	0,9
2016	NEP10	15	1	1,55	0
2016	NEP32	192	7	0,43	0
2016	NEP33	1003	156	1,52	0
2016	NEP34	439	20	1,73	0
2016	NEP5	1516	2046	1,67	0,53
2016	NEP6	1854	272	1	0
2016	NEP7	2399	0	1	Inf
2016	NEP8	1937	165	1	0,98
2016	NEP9	1146	95	1	0,99
2016	NEPOTH-NS	966	552	1,14	2,46
2016	PLE-EC	3823	2969	0,93	0,96
2016	PLE-NS	94623	45146	0,95	0,9
2016	POK	67620	10052	1,01	0,83
2016	WHG-NS	20555	13204	1	0,87
2016	SOL-EC	2538	344	1	1,01
2016	SOL-NS	13666	1484	0,98	0,77

**Table 2.3.1.2 Summary of the 2017 landings and target Fs/harvest ratios, resulting from the Advice Approaches considered by ICES. Target Fs are left justified; harvest ratios are right justified. Where a stock/Functional Unit does not have a management plan, the landings follow ICES advice.**

SPECIES	AGREED TAC (SUMMED TACs) – 2016	WANTED		F/HARVEST RATIO FOR 2017	F/HARVEST RATIO FOR 2018	SSB 2018	SSB 2019	RATIONAL
		CATCH – ADVICE FOR 2018	CATCH – ADVICE FOR 2018					
Cod 3.a-4-7.d	5744 + 39 220 + 2059 = 47 023 (3.a+4+7.d)	< 59 888 t	< 41 309 t	0.35	0.31	204 267 t	216 473 t	MSY approach
Haddock 3.a-4-6.a	2069 + 33 643 + 3697 = 39 409 (3.a+4+6.a)	< 50 056 t	< 42 722 t	0.183	0.19	229 910 t	267 865 t	MSY approach
Plaice 3.a-4	17 639 +129 917 = 147 610 (3.a+4)	< 134 238 t	< 94 866 t	0.202	0.21	959 446 t	975 653 t	MSY approach
Sole 4	16 123	< 14 900t	< 14 017 t	0.21	0.20	62 818 t	61 164 t	MP
Saithe 3.a-4-6	100 287 + 10 404 = 110 691 (4+6)	< 118 460t	<103 731 t	0.381	0.36	272 061 t	279 689 t	MSY approach
Whiting 4-7.d	16 003 / 0.80 = 20 003 (Landings ratio 4–7.d)	< 26 804 t	< 13 445 t	0.244	0.15	354 119 t	354 527 t	MSY approach
Sole 7.d	2769	< 3866 t	< 3429 t	0.23	0.243	18260 t	18697 t	MSY approach
Plaice 7.d	12 378 x 0.767 = 9494 (Landings ratio 7.d–7.e)	< 10 592 t	< 7132 t	0.133	0.25	55 798 t	46 483 t	MSY approach
Nephrops in Botney Gut (FU 5)		< 1391 t	< 1334 t					Precautionary approach
Nephrops in Farn Deepes (FU 6)		< 1135 t	< 1014 t	8.1	6.60			MSY approach
Nephrops in Fladen Ground (FU 7)		< 13 264 t	< 13 264 t	1.4	7.50			MSY approach
Nephrops in Firth of Forth (FU 8)		< 2826 t	< 2748 t	12.30	16.30			MSY approach
Nephrops in Moray Firth (FU 9)		< 1170 t	< 1089 t	12.7	11.80			MSY approach
Nephrops in Noup (FU 10)		< 40 t	< 38 t					Data limited approach
Nephrops in Norwegian Deep (FU 32)		< 496 t	< 464 t					Precautionary approach
Nephrops in Horn's Reef (FU 33)		< 1257 t	< 1257 t					Data limited approach
Nephrops in Devil's Hole (FU 34)		< 492 t	< 459 t					Data limited approach
Nephrops in other rectangles (NEPOTH)		< 610 t	< 610 t					Data limited approach
Nephrops in Division 3.a		< 12053 t	< 11 380 t	3.10	7.90			MSY approach

\*Proxy TAC based on landings split in 201

\*\*based on split 3.a-4-7.d,e landings



Table 2.4.2.1 Métiers consistent with the cod long-term management plan and AER database.

Gear	Mesh Size	fleet	Métier
Gillnet		Static	GN1
Pots			OTH
Longlines			LL1
Trammel			GT1
Pelagic Trawl		Pelagic	OTH
Pelagic Seine			OTH
Demersale Seine	>=120	Dseine	TR1
	110-119		TR2
	90-99		
	80_89		
	70-79		
16-31	TR3		
Otter	>=120	Otter	TR1
	110-119		TR2
	90-99		
	80_89		
	70-79		
16-31	TR3		
Beam	>=120	Beam	BT1
	110-119		BT2
	90-99		
	80_89		
Dredge		Dredge	OTH

**Table 2.4.2.a Final fleet and métier categories used in the mixed fishery analysis. 4, 3AN and 7D refer to ICES area.**

FLEET	METIER	EFFORT	CATCH	FLEET	METIER	EFFORT	CATCH	
BE_Beam<24	BT2.4	441.41	1357.23	FR_Otter>=40	OTH	1147.08	17.59	
	BT2.7D	281.27	841.57		TR1.4	5099.72	8459.59	
	OTH	664.69	26.34		FR_Otter10-40	OTH	1315.32	108.81
BE_Beam>=24	BT1.4	1457.18	5827.74	FR_U10m	TR2.4	1436.60	4128.15	
	BT2.4	1321.52	3356.25		TR2.7D	8418.56	7512.97	
	BT2.7D	1965.28	2036.54		OTH	104.88	26.00	
BE_Otter	OTH	167.55	1052.60	GE_Beam>=24	TR2.7D	144.05	231.08	
	TR2.4	584.99	3196.76		BT2.4	959.86	2442.17	
BE_Static	GT1.7D	44.85	57.72	GE_FDF	OTH	61.57	284.68	
	OTH	63.46	32.60		OTH	21.78	169.03	
DK_Beam	BT1.4	355.93	1434.41	GE_Otter<24	TR1.4	433.85	4352.92	
	OTH	70.66	283.31		OTH	15.81	96.34	
DK_FDF	OTH	15.47	74.81	GE_Otter>=40	TR1.4	128.21	1736.16	
	TR1.3AN	297.83	2605.87		TR2.4	124.17	3047.13	
	TR1.4	1691.25	7371.62		OTH	5.85	45.83	
	TR2.4	63.77	313.16		TR1.4	458.51	4146.21	
	OTH	438.26	181.47		GE_Otter24-40	OTH	38.09	141.48
DK_Otter<24	TR1.3AN	304.66	1947.88	NL_Beam<24	TR1.4	394.27	2861.54	
	TR1.4	309.97	2383.52		TR2.4	109.82	1319.03	
	TR2.3AN	1931.14	3476.85		BT2.4	230.25	1621.27	
	TR2.4	102.52	769.51		OTH	4.17	46.97	
	OTH	1173.60	1134.08		NL_Beam>=40	BT1.3AN	162.81	1141.35
DK_Otter24-40	TR1.4	672.23	3217.83	NL_Beam>=40	BT1.4	800.68	3732.71	
	TR2.4	212.59	1560.88		BT2.4	15771.64	44623.00	
	TR1.3AN	319.28	4234.85		OTH	2288.70	65.53	
DK_Seine	TR1.4	551.83	3631.57	NL_Beam24-40	BT2.4	9.71	6977.26	
	GN1.3AN	290.73	912.57		NL_Otter	OTH	89.97	5.64
	GN1.4	1416.05	5768.72		TR1.3AN	1004.01	960.97	
DK_Static	OTH	58.77	195.07	NO_Otter<40	TR1.4	1286.98	6544.98	
	BT1.4	1576.60	6707.23		TR2.4	927.29	9902.53	
	BT2.4	1548.14	4959.73		TR2.7D	2032.64	1138.87	
EN_Beam	BT2.7D	185.71	372.96	NO_Otter>=40	OTH	1959.41	958.94	
	OTH	2.21	3.68		TR1.4	5155.91	11425.94	
	TR1.4	1342.56	11370.27		NO_Static	GN1.4	671.28	4384.89
	EN_Otter<24	OTH	156.54		79.78	LL1.4	4.82	2124.28
EN_Otter24-40	TR1.4	112.84	500.77	OTH_OTH	OTH	50379.59	199.00	
	TR2.4	936.59	2155.58		OTH	3.17	12143.20	
	EN_Otter>=40	OTH	72.08		225.62	SC_FDF	OTH	1956.76
EN_Otter24-40	TR1.4	586.46	1797.80	SC_Otter<24	TR1.4	0.93	17230.89	
	OTH	173.52	481.66		OTH	3901.88	2.89	
EN_U10	TR1.4	301.30	2282.54	SC_Otter>=24	TR1.4	3183.89	18445.99	
	GN1.7D	732.40	729.22		TR2.4	4281.56	11689.65	
	GT1.7D	353.34	410.84		TR1.4	148.94	28090.73	
	OTH	3357.10	841.16		TR2.4	678.24	570.31	
	TR2.4	553.11	1667.86		SC_Static	OTH	4244.73	148.98
FR_Beam	TR2.7D	121.51	158.28	SC_U10_OTB	pots.4	2.24	35.18	
	BT2.7D	247.89	305.40		OTH	447.40	6.53	
	OTH	28.91	108.70		TR2.4	3609.65	727.86	
FR_Nets	GT1.4	801.56	956.82	SW_Otter	OTH	236.05	2365.17	
	GT1.7D	2691.92	2812.15		TR1.4	9777.00	1502.24	
	OTH	103.83	105.27					

**Table 2.5.2.1.a Baseline run outputs from the Fcube FLR package.**

		COD-NS	HAD	PLE-NS	POK	SOL-NS	WHG-NS	PLE-EC	SOL-EC
2017	Fbar	0,35	0,18	0,20	0,39	0,21	0,24	0,13	0,23
	FmultVsF16	1	0,645	1	1,387	0,953	1	1,00	1,00
	landings	40759	39409	96767	106331	14995	24407	4232	3117
	ssb	167925	237220	936773	251769	67961	305135	59712	17784
2018	Fbar	0,31	0,19	0,21	0,36	0,20	0,15	0,25	0,24
	FmultVsF16	0,882	0,67	1,041	1,272	0,929	0,616	1,88	1,05
	landings	39638	50284	95812	100134	14244	16968	7137	3866
	ssb	199525	229741	959446	260232	63477	353984	55845	18260
2019	ssb	208502	267716	975653	267781	63769	353841	46665	18697

		NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS
2017	Fbar						0,13	0,01	0,12	0,13	
	FmultVsF16						0,95	0,91	0,96	1,01	
	landings	15	184	1074	425	3301	1971	2224	1948	1150	1407
2018	Fbar						0,07	0,08	0,16	0,12	
	FmultVsF16						0,50	5,36	1,33	0,93	
	landings	39	484	1219	477	1105	1016	12962	2649	1048	525

**Table 2.5.2.1.b Comparison between baseline run and ICES advice for finfish. Figures for 2015 compare results from the baseline run to the ICES intermediate year results. The baseline run uses the same assumptions for F in the intermediate year as the forecasts leading to ICES advice.**

			COD-NS	HAD	PLE-EC	PLE-NS	baseline.POK	SOL-EC	SOL-NS	WHG-NS
2017	catch	baseline	53132	45057	6515	137588	123242	3596	16123	40565
		ICES	55207	45084	6498	137636	123135	3596	16123	40010
		diff	-3.8	-0.1	0.3	0	0.1	0	0	1.4
	Fbar	baseline	0.352	0.183	0.133	0.202	0.39	0.231	0.205	0.244
		ICES	0.35155	0.183	0.133	0.202	0.381	0.23107	0.2069	0.24362
		diff	0.1	0	0	0	2.4	0	-0.9	0.2
	landings	baseline	40759	39409	4232	96767	106331	3117	14995	24407
		ICES	41939	39409	4232	96767	106331	3117	15029.12834	24460
		diff	-2.8	0	0	0	0	0	-0.2	-0.2
	ssb	baseline	167925	237220	59712	936773	251769	17784	67961	305135
		ICES	167712	237756	59712	936773	257329	17784	67961.04299	305405
		diff	0.1	-0.2	0	0	-2.2	0	0	-0.1
2018	catch	baseline	58292	50284	10663	135587	114788	3866	15199	27685
		ICES	59888	50056	10592	134238	118460	3866	14900	26804
		diff	-2.7	0.5	0.7	1	-3.1	0	2	3.3
	Fbar	baseline	0.31	0.19	0.25	0.21	0.358	0.243	0.2	0.15
		ICES	0.31	0.19	0.25	0.21	0.358	0.243	0.2	0.15
		diff	0	0	0	0	0	0	0	0
	landings	baseline	39638	50284	7137	95812	100134	3866	14244	16968
		ICES	41309	50056	7132	94866	103731	3866	14900	17374
		diff	-4	0.5	0.1	1	-3.5	0	-4.4	-2.3
	ssb	baseline	199525	229741	55845	959446	260232	18260	63477	353984
		ICES	204267	229910	56004	995564	272061	18260	63353	354119
		diff	-2.3	-0.1	-0.3	-3.6	-4.3	0	0.2	0
2019	ssb	baseline	208502	267716	46665	975653	267781	18697	63769	353841
		ICES	216473	267865	46483	975653	279689	18697	61164	354527
		diff	-3.7	-0.1	0.4	0	-4.3	0	4.3	-0.2

\* value corresponding to catches, not landings. For HAD, SOL-NS and SOL-EC, a landing obligation is implemented in 2017 in the forecast. The landings for 2017 are equal to the catches.

**Table 2.5.2.1.c Comparison between baseline run and ICES advice for *Nephrops*.** The values for *Nephrops* FUs that do not receive an absolute ICES abundance estimate are set according to the ICES approach for data-limited *Nephrops* stocks. No 'ICES advice' values are given for *Nephrops* in the intermediate year because the baseline run uses values based on recorded landings in the previous year which can vary significantly from the advice for each FU.

		STOCK	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEP34	NEPOTH-NS
2018	landings	ICES	895	1029	13264	2441	1105	40	464	1119	459	525
		base line	1105	1016	12962	2649	1048	40	484	1219	477	525
		% difference	23.5	-1.3	-2.3	8.5	-5.2	0	4.3	8.9	3.9	0

\*These numbers are landings values - ICES advice does not provide total catch.

Table 2.5.2.2.a Results of Final Fcube runs.

		COD-NS	HAD	PLE-NS	POK	SOL-NS	WHG-NS	NEP10	NEP32	NEP33	NEP34	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH-NS	NEP Tot	PLE-EC	SOL-EC	
landings	2017 baseline	40759	39409	96767	106331	14995	24407	15	184	1074	425	3301	1971	2224	1948	1150	1407	13699	4232	3117	
Fbar	2016 baseline	0.35	0.28	0.20	0.28	0.22	0.24						0.13	0.01	0.12	0.13				0.13	0.23
	2017 baseline	0.35	0.18	0.20	0.39	0.21	0.24						0.13	0.01	0.12	0.13				0.13	0.23
	2018 baseline	0.31	0.19	0.21	0.36	0.20	0.15						0.07	0.08	0.16	0.12				0.25	0.24
	had	0.32	0.19	0.21	0.20	0.18	0.13						0.08	0.01	0.08	0.07				0.11	0.18
	max	1.44	1.27	0.65	0.61	0.34	0.87						0.65	0.08	0.60	0.57				0.32	0.41
	min	0.25	0.16	0.17	0.18	0.15	0.08						0.06	0.01	0.06	0.06				0.08	0.13
	pok	0.53	0.34	0.36	0.36	0.28	0.26						0.20	0.02	0.18	0.17				0.18	0.26
	sq_E	0.41	0.27	0.28	0.28	0.23	0.20						0.15	0.01	0.14	0.13				0.14	0.22
	val	0.35	0.22	0.24	0.28	0.20	0.18						0.13	0.01	0.10	0.10				0.14	0.23
FmultVsF16	2017 baseline	1	0.645	1	1.387	0.953	1						0.95	0.91	0.96	1.01				1.00	1.00
	sq_E	1.16	0.95	1.39	0.98	1.06	0.83						0.93	1.06	0.98	0.98				1.08	0.97
	val	1.06	0.83	1.17	1.05	0.91	0.8						0.85	0.92	0.86	0.85				1.03	0.93
	2018 baseline	0.882	0.67	1.041	1.272	0.929	0.616						0.50	5.36	1.33	0.93				1.88	1.05
	had	0.9	0.67	1.04	0.71	0.85	0.54						0.63	0.63	0.62	0.57				0.82	0.77
	max	4.09	4.47	3.21	2.17	1.57	3.59						4.92	5.36	4.91	4.52				2.40	1.77
	min	0.72	0.56	0.83	0.63	0.71	0.32						0.47	0.52	0.51	0.47				0.59	0.57
	pok	1.5	1.21	1.78	1.27	1.3	1.08						1.49	1.32	1.46	1.35				1.35	1.11
	sq_E	1.16	0.93	1.39	0.98	1.06	0.83						1.15	1.02	1.13	1.04				1.08	0.94
	val	1.01	0.76	1.17	1.01	0.91	0.74						1.00	0.75	0.84	0.78				1.08	0.97
landings	2017 baseline	40759	39409	96767	106331	14995	24407	15	184	1074	425	3301	1971	2224	1948	1150	1407	13699	4232	3117	
	sq_E	46167	55664	130203	78997	16425	20669	16	193	1125	446	3458	1912	2615	1989	1123	1474	14351	4554	3046	
	val	42815	49317	112042	84121	14364	19926	14	170	993	393	3051	1752	2272	1740	976	1300	12662	4346	2925	
	2018 baseline	39638	50284	95812	100134	14244	16968	39	484	1219	477	1105	1016	12962	2649	1048	525	21524	7137	3866	
	had	42483	50284	96051	70680	13473	15936	10	130	329	129	298	1293	1551	1265	654	141	5800	3352	3012	
	max	120939	220293	244040	165263	22669	80061	85	1053	2653	1038	2404	10153	13157	9971	5176	1142	46831	8841	6132	
	min	32653	41436	75208	58443	11182	9373	8	105	265	104	240	978	1284	1042	543	114	4685	2400	2254	
	pok	52343	75234	130982	100134	17429	27977	24	297	748	293	678	3084	3252	2969	1544	322	13211	4985	3909	
	sq_E	48045	64286	115925	87792	15618	23089	18	229	577	226	523	2376	2506	2288	1190	248	10181	4234	3517	
	val	43691	54641	103345	88259	14168	20821	14	179	450	176	408	2074	1853	1705	888	194	7940	4274	3664	
discards	2017 had	9874	5648	39994	8682	980	9727													1901	393
	pok	18128	11137	72466	16474	1585	18888													3237	565
	sq_E	13386	8104	54651	12096	1239	13604													2452	464
	2018 had	18380	0	39911	9089	890	9740													1655	0
	max	59302	0	97517	23164	1541	54245													4348	0
	min	14725	0	31525	7828	742	5780													1195	0
	pok	27037	0	54753	14224	1230	18162													2505	0
	sq_E	22376	0	48274	11779	1061	14505													2104	0
	val	19857	0	43020	11953	946	13012													2120	0
Ld_MgtPlan	2018 sq_E	37931	47451	82212	109776	13939	17356	39	484	1219	477	1105	1016	12962	2649	1048	525	21524	7066	3885	
ssb	2017 baseline	167925	237220	936773	251769	67961	305135													59712	17784
	2018 baseline	199525	229741	959446	260232	63477	353984													55845	18260
	2019 baseline	208502	267716	975653	267781	63769	353841													46665	18697
ssb	2017 sq_E	167925	237220	936773	251769	67961	305135													59712	17784
	2018 sq_E	192008	212729	912241	289314	62051	358992													55287	18345
	2019 had	214510	267716	978944	362988	66631	363256													53909	20251
	max	91380	106861	745833	226078	56174	274853													43802	16634
	min	215196	266155	978476	341644	67469	367550													54012	20594
	pok	156291	208920	794999	267781	54211	335921													46978	17902
	sq_E	187234	238305	890225	316163	60859	349038													50709	19146
	val	199183	253692	938847	309074	64530	352637													51004	19151

Table 2.5.2.2.c Landings under the mixed fisheries scenarios relative to the single stock advice.

Stock	Single-stock catch advice (2017) *	Catch per mixed-fisheries scenario (2018)					Value	Optim
		Maximum	Minimum	HAD	POK	Status quo effort		
Cod in 4, 7.d, 3.a.20	59888,0	3,0	0,8	1,0	1,3	1,2	1,1	1,1
Haddock in 4, 6.a, 3.a.20	50056,0	4,4	0,8	1,0	1,5	1,3	1,1	1,0
Plaice in 7.d	10592,0	1,2	0,3	0,5	0,7	0,6	0,6	0,9
Plaice in 4	134238,0	2,5	0,8	1,0	1,4	1,2	1,1	1,1
Saithe in 4, 6, 3.a.20	118460,0	1,6	0,6	0,7	1,0	0,8	0,8	0,8
Sole in 7.d	3866,0	1,6	0,6	0,8	1,0	0,9	0,9	1,0
Sole in 4	14900,0	1,6	0,8	1,0	1,3	1,1	1,0	1,0
Whiting in 4, 7.d	26804,0	5,0	0,6	1,0	1,7	1,4	1,3	NA
Nephrops FU 5	1159,0	2,1	0,2	0,3	0,6	0,5	0,4	NA
Nephrops FU 6	1152,0	8,8	0,8	1,1	2,7	2,1	1,8	NA
Nephrops FU 7	13264,0	1,0	0,1	0,1	0,2	0,2	0,1	NA
Nephrops FU 8	2745,0	3,6	0,4	0,5	1,1	0,8	0,6	NA
Nephrops FU 9	1188,0	4,4	0,5	0,6	1,3	1,0	0,7	NA
Nephrops FU 10	40,0	2,1	0,2	0,3	0,6	0,5	0,4	NA
Nephrops FU 32	496,0	2,1	0,2	0,3	0,6	0,5	0,4	NA
Nephrops FU 33	1257,0	2,1	0,2	0,3	0,6	0,5	0,4	NA
Nephrops FU 34	492,0	2,1	0,2	0,3	0,6	0,5	0,4	NA
Nephrops other in 4	525,0	2,2	0,2	0,3	0,6	0,5	0,4	NA

\* Advised catches no more than the indicated value.

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

## Total Landings by Stock

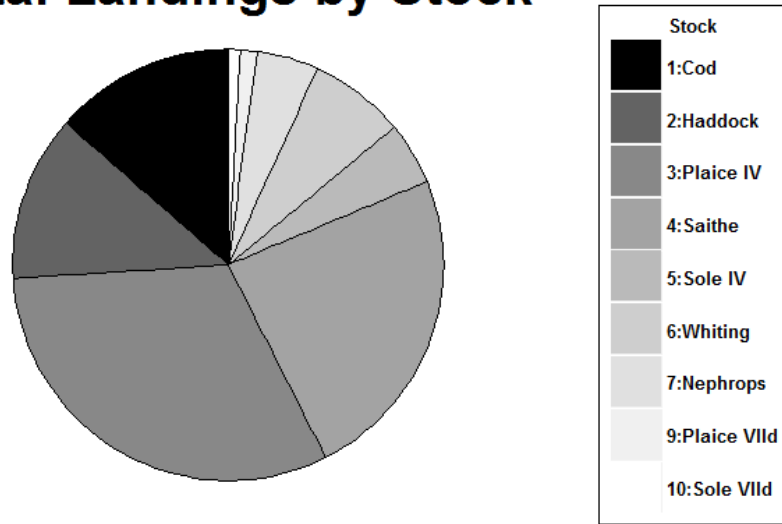


Figure 2.4.1 Distribution of landings of those stocks included in the mixed fisheries projections.

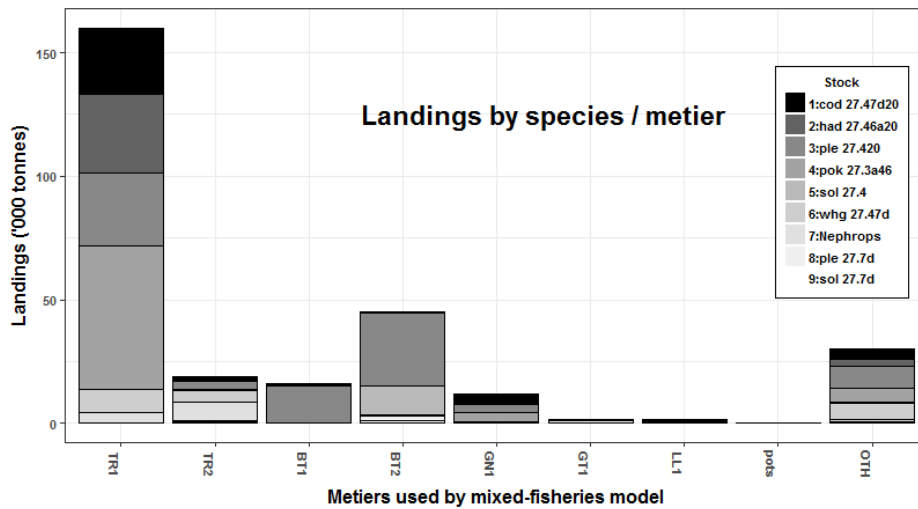


Figure 2.4.2.a Landings distribution of species by métier with landings consisting of  $\geq 1\%$  of any of the stocks 1–10 in 2014 Note: The “other” (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and métier 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 6 and 6.a respectively.



**Share of Landings and Discards compare to single-species analyses**

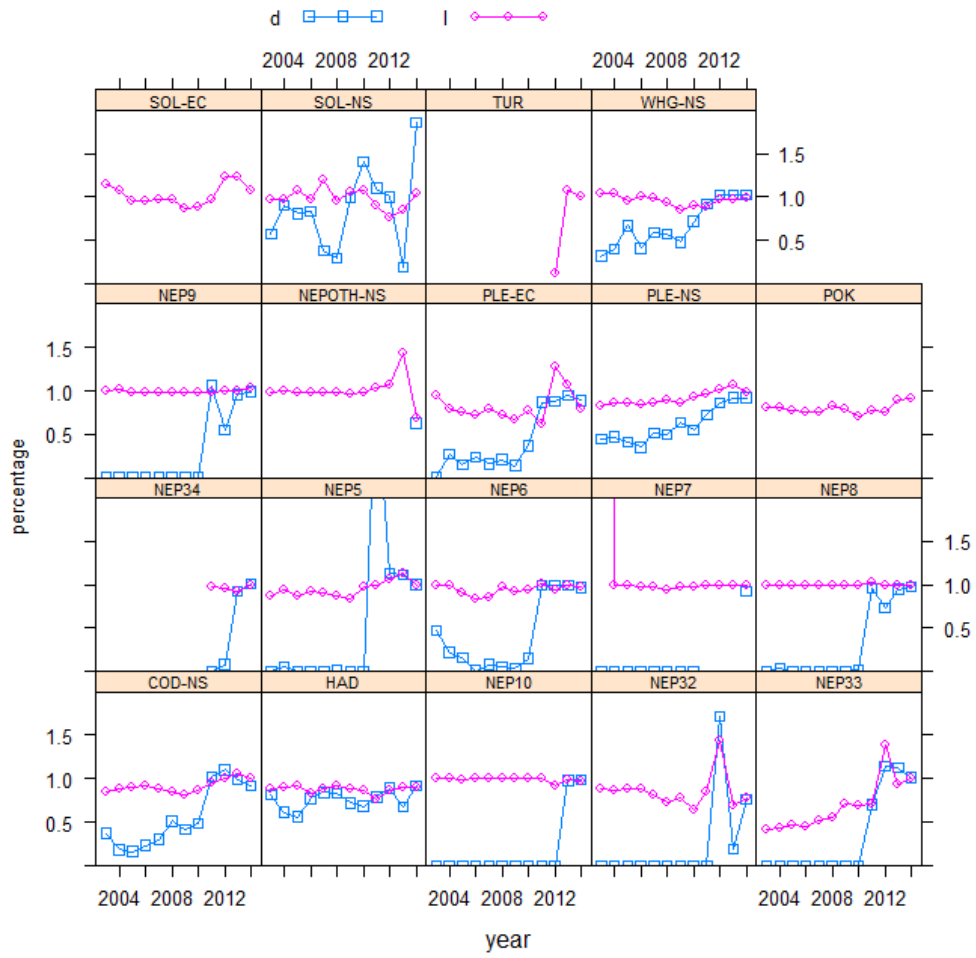


Figure 2.4.2.c Ratio between the sum of landings and discards across fleets used in the MIXFISH analysis and the landings and discards estimated by the WGNSSK stock assessments.

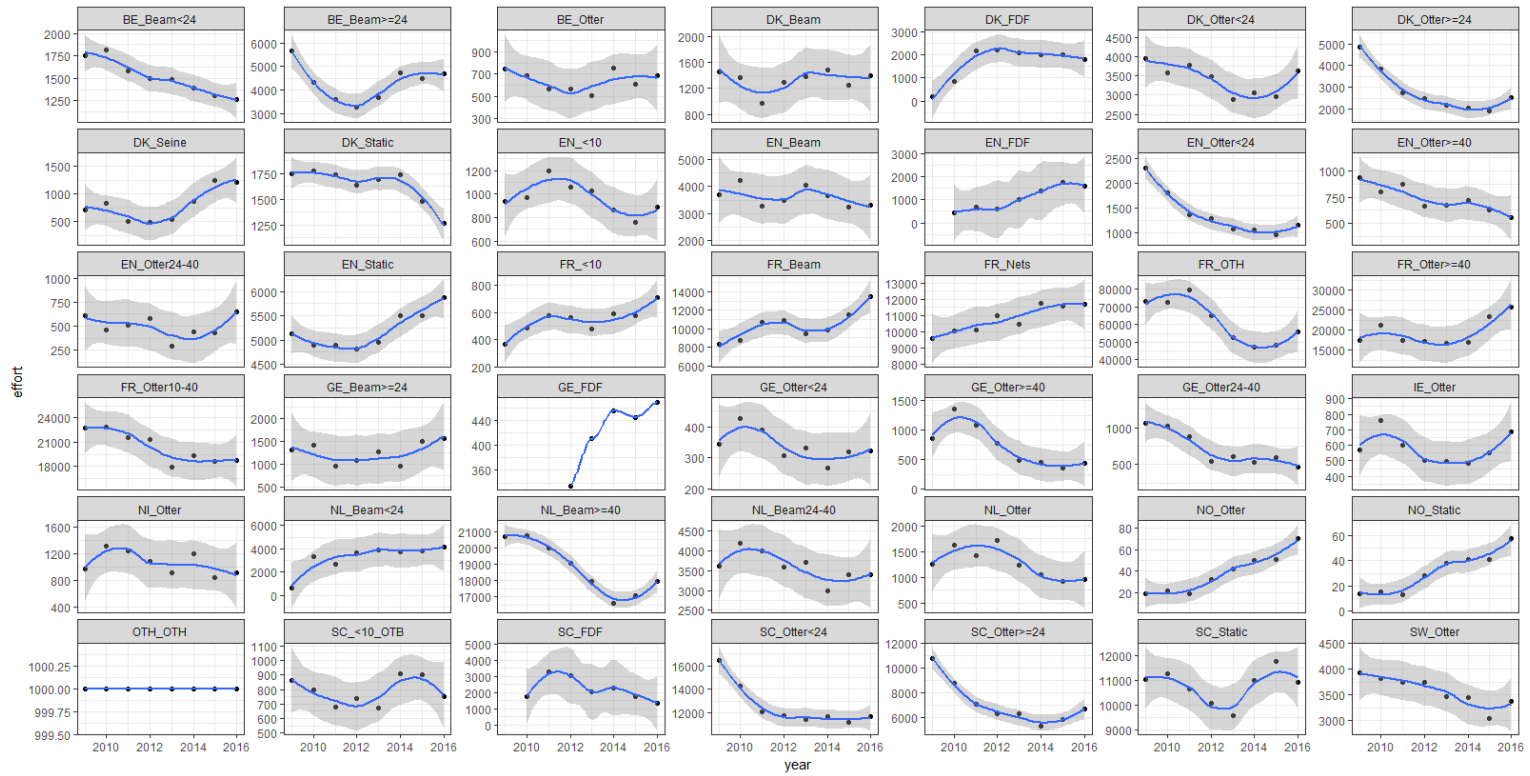


Figure 2.4.3.a Effort by fleet and year for the North Sea demersal fleets, in '000 KWdays.

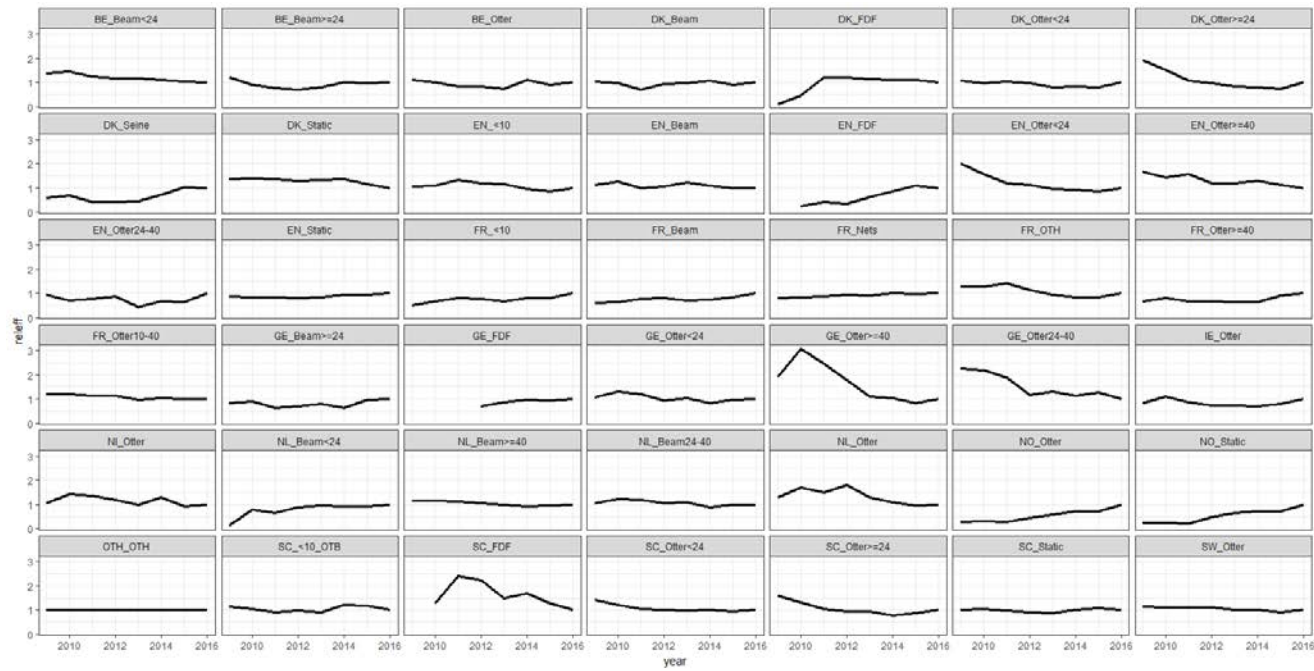


Figure 2.4.3.b Relative trends (compared to the 2016 value) in effort (KW Days) by fleet and year for the North Sea demersal fleets..

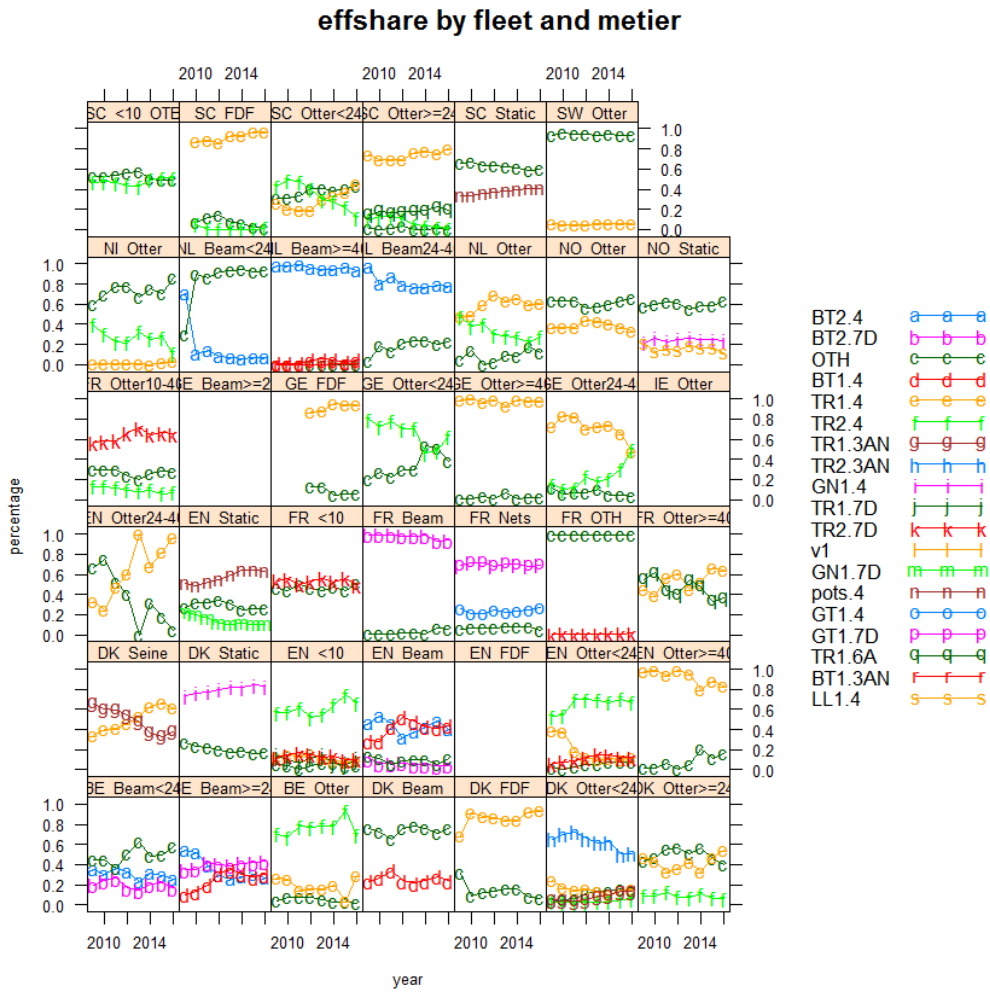


Figure 2.4.3.c Effort share (in proportion) by métier for each fleet.

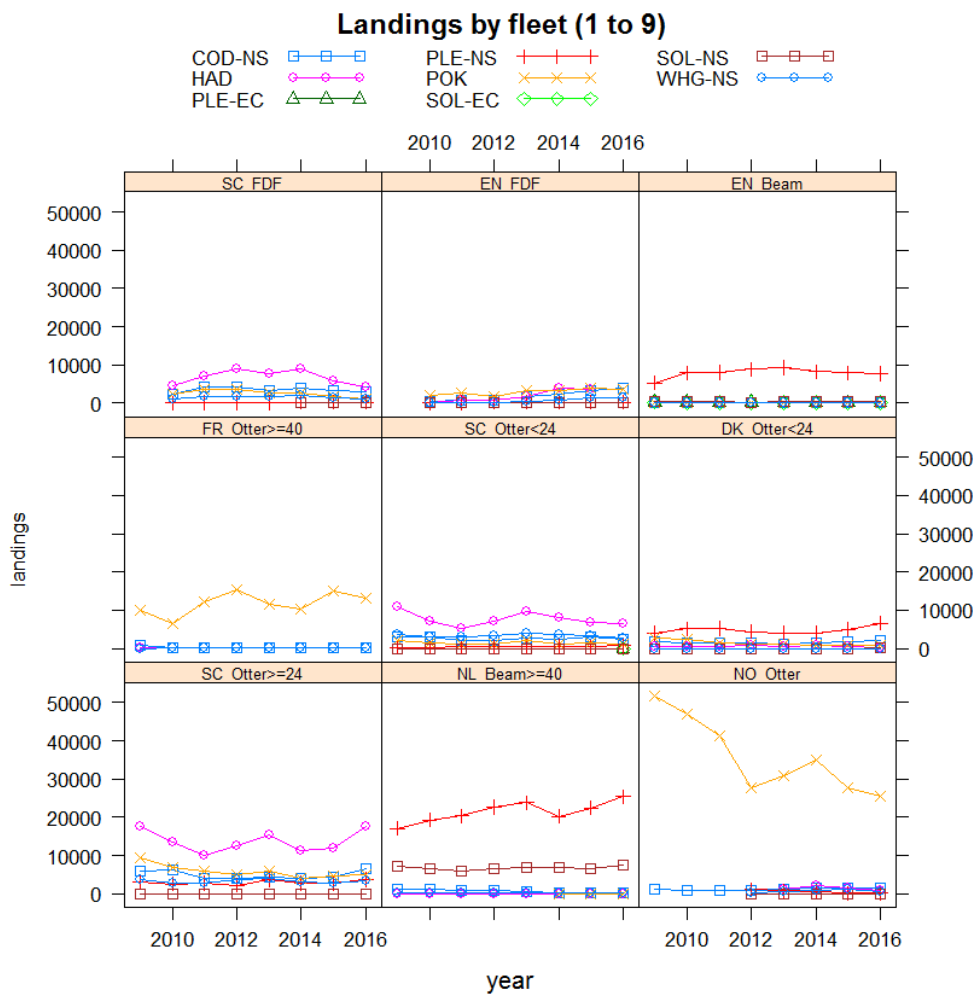


Figure 2.4.3.d Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

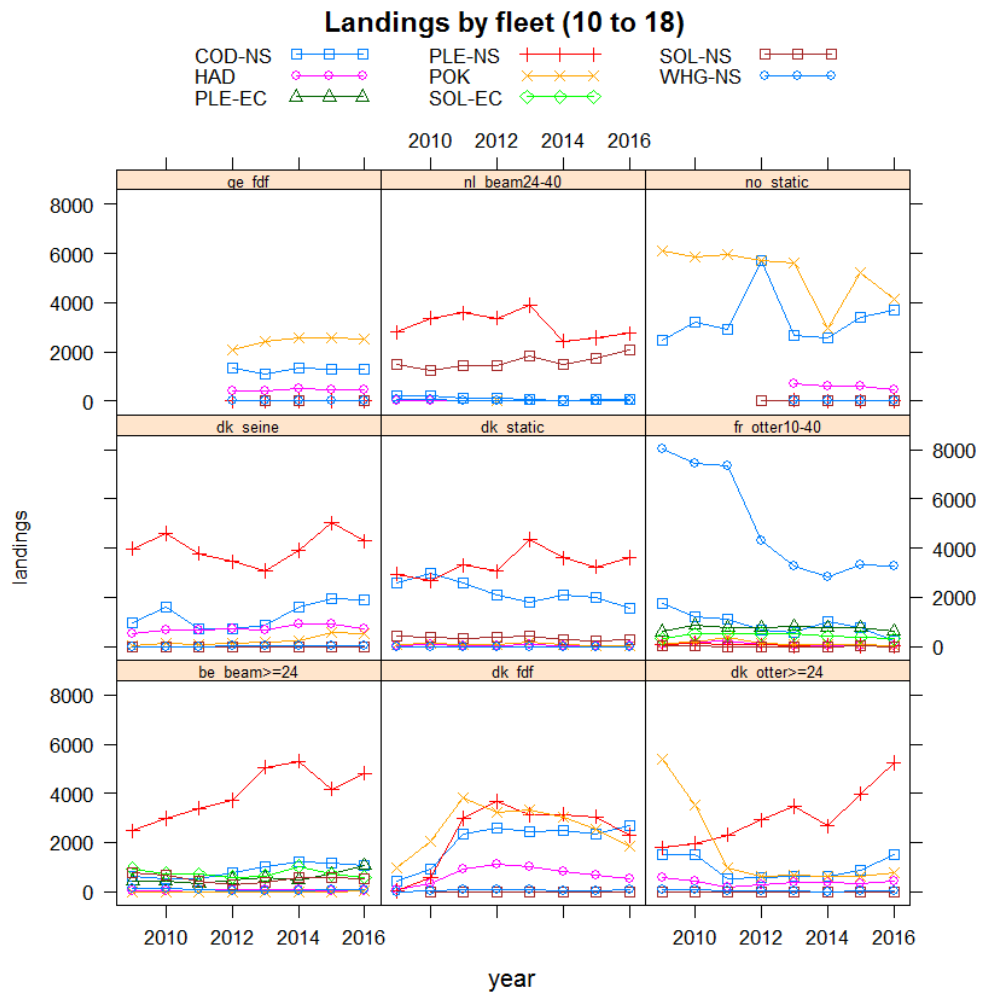


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

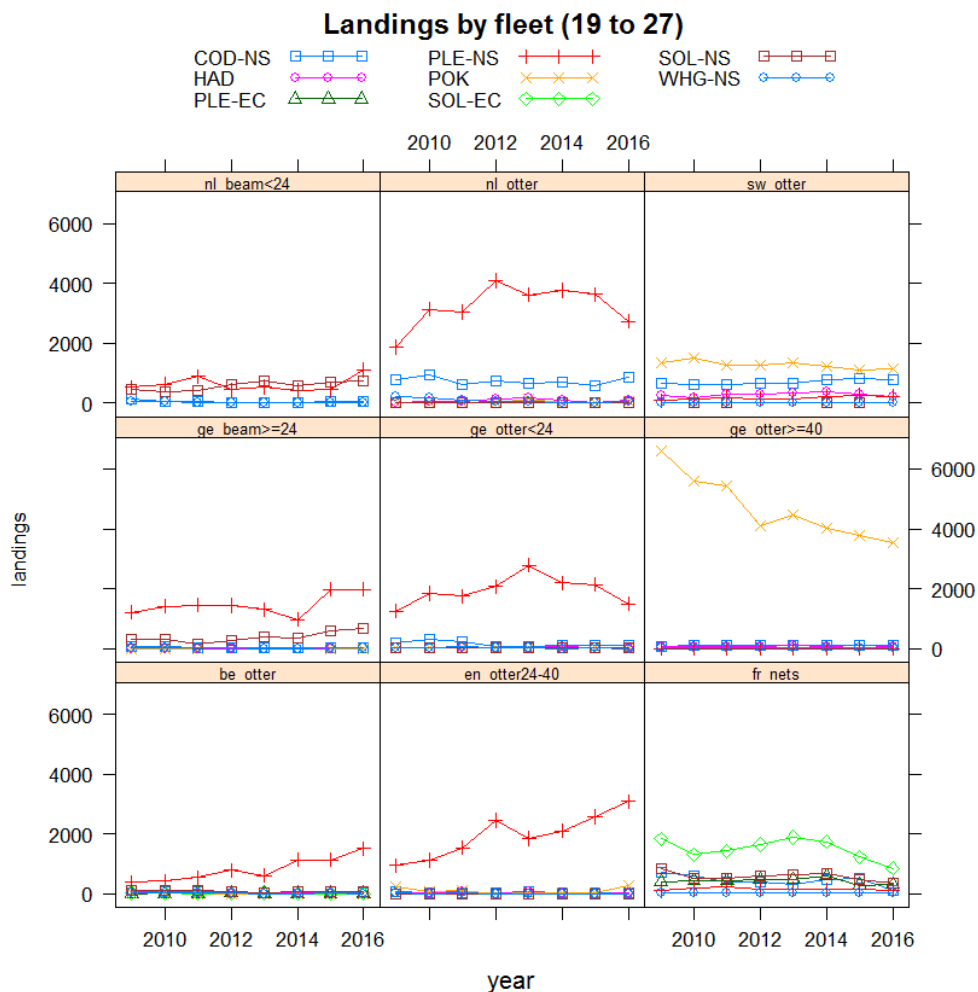


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

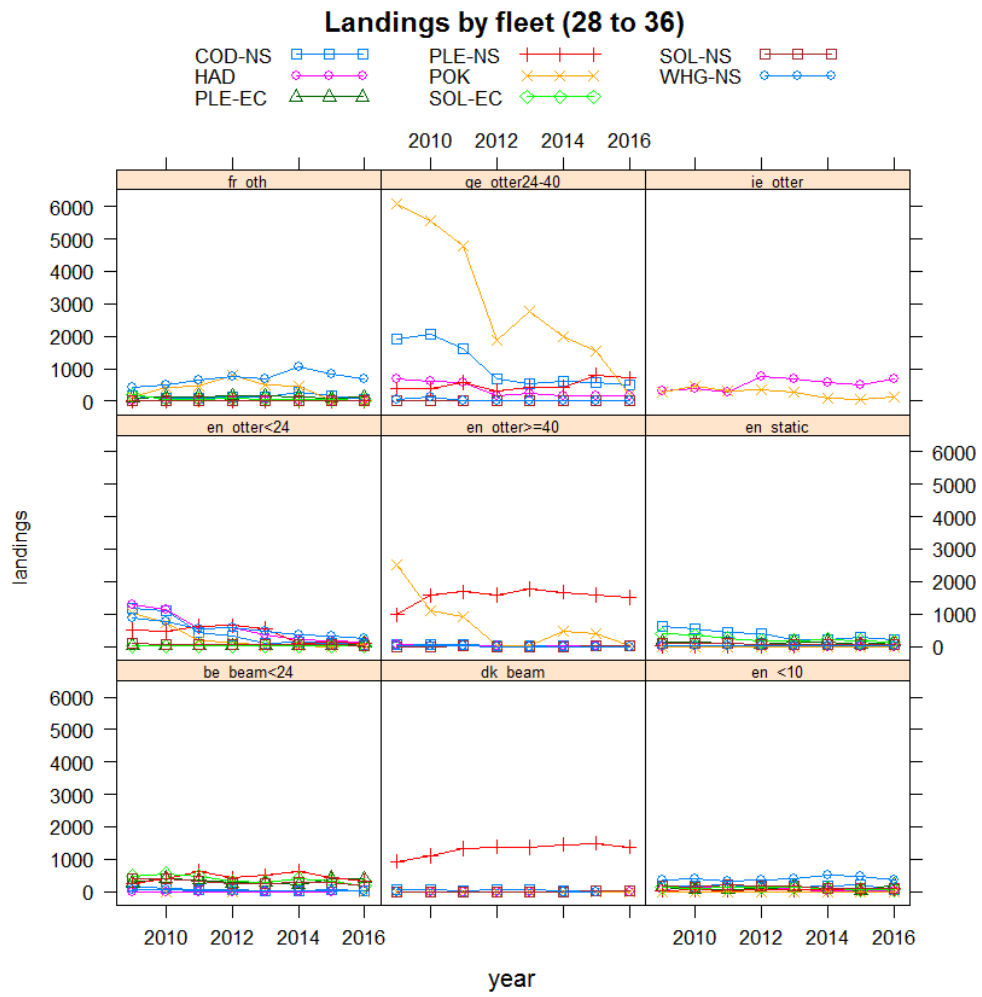


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.



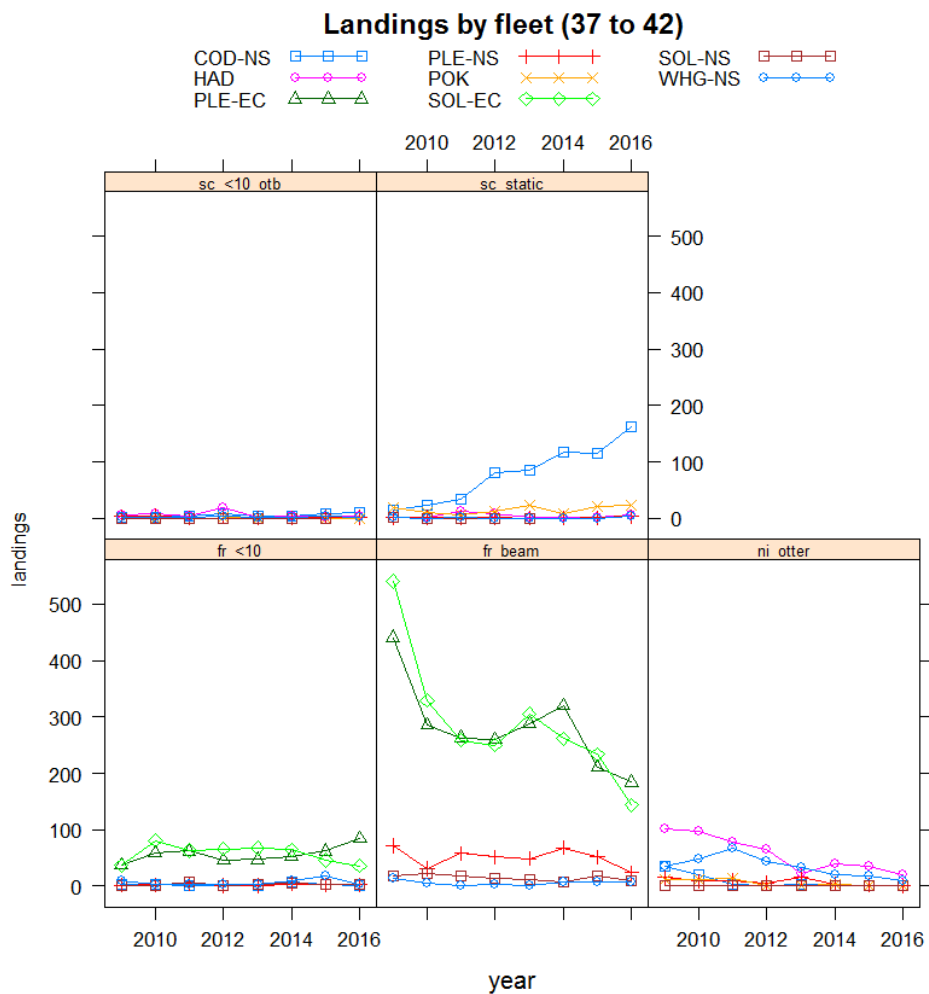


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

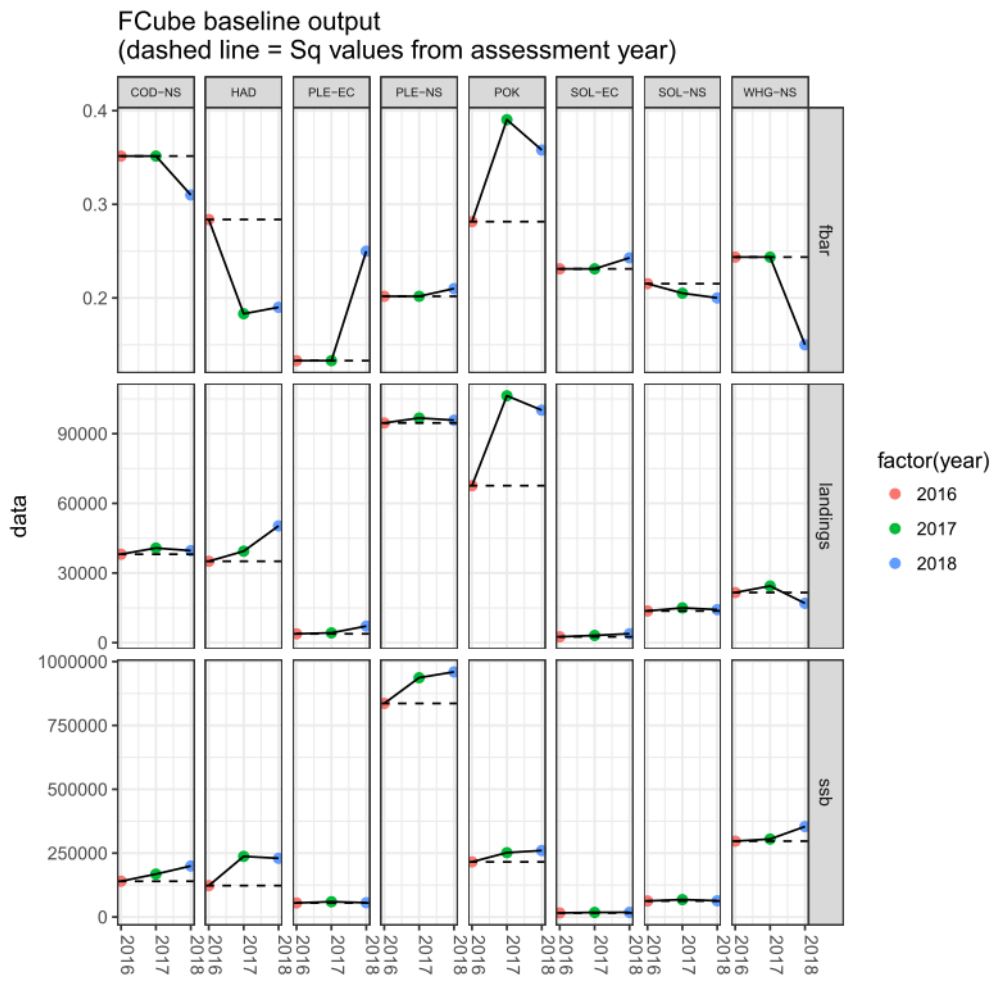


Figure 2.5.2.1.a Summary of the relative changes in the single stock advice for 2018 compared to the situation in 2016.

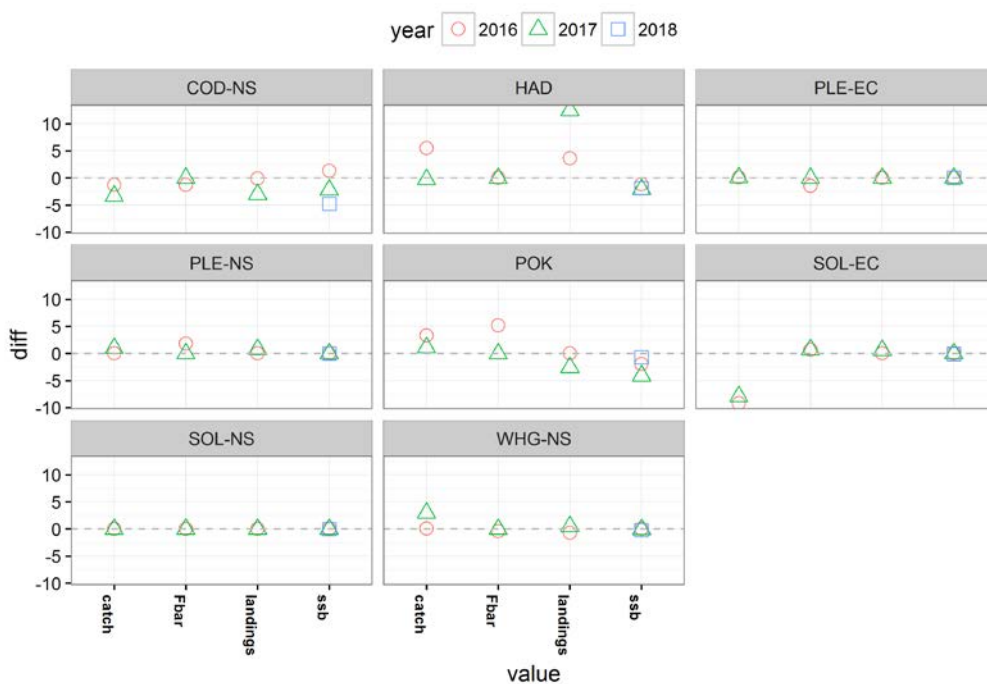


Figure 2.5.2.1.b Difference between Fcube baseline run and Single Species advice for finfish stocks, showing Fbar (2016–2017), landings (2016–2017) and SSB (2017–2018).

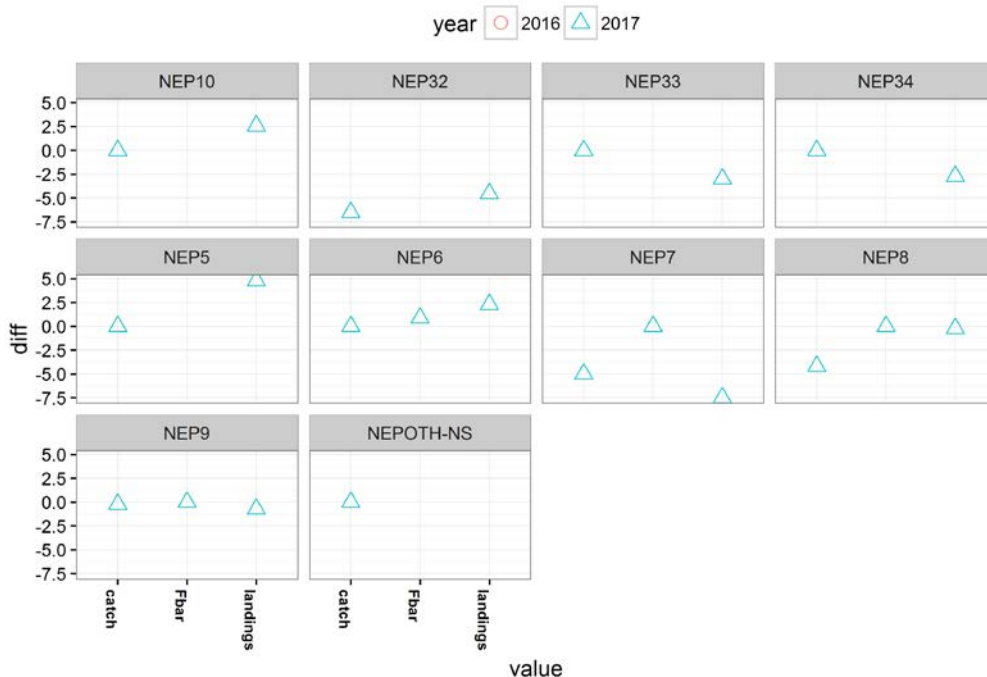


Figure 5.2.1.2b Difference between Fcube baseline run and single species advice for *Nephrops* stocks. Catch, Fbar and landings in 2017 only shown as harvest in intermediate year is not directly comparable. Fbar not shown for some stocks as they are non-analytical assessments.

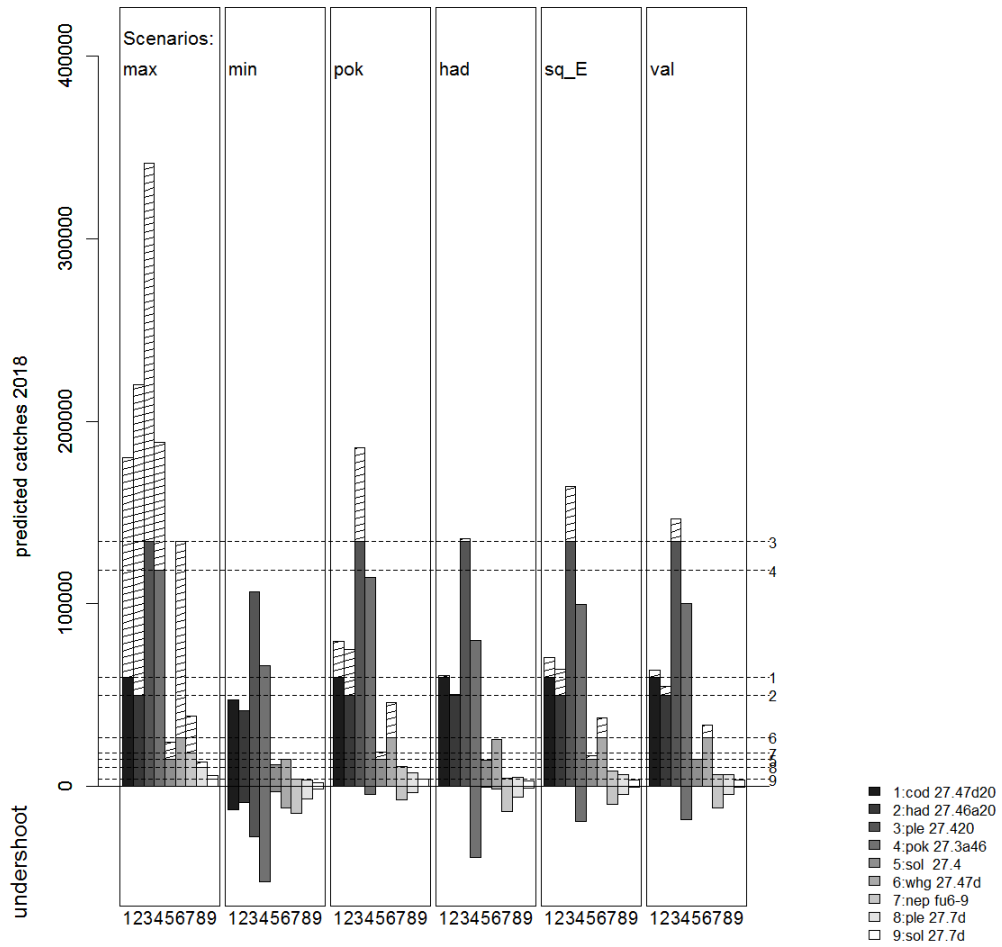


Figure 2.5.2.2.a TAC year results (2017). Fcube estimates of potential catches by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single stock advice. Bars below the value of zero show the scale of undershoot (compared to the single species catch advice) in cases where catches are predicted to be lower when applying the scenario.

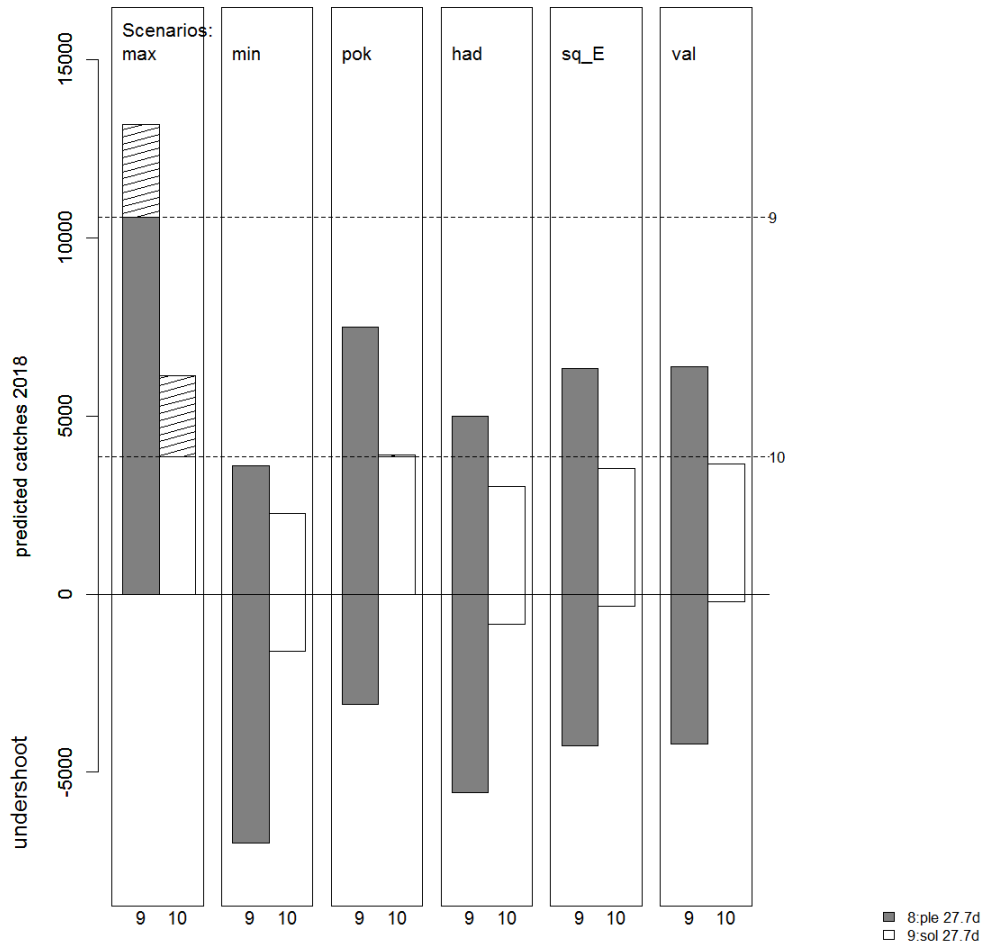


Figure 2.5.2.2.b TAC year results for the stocks subject to lower landings (detail from Figure 4.2.2.2.1). Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the single stock catch advice for 2017. Bars below the value of zero show the scale of undershoot (compared to single stock catch advice) in cases where catches are predicted to be lower when applying the scenario. Hatched columns represent catches in overshoot of the single stock catch advice.

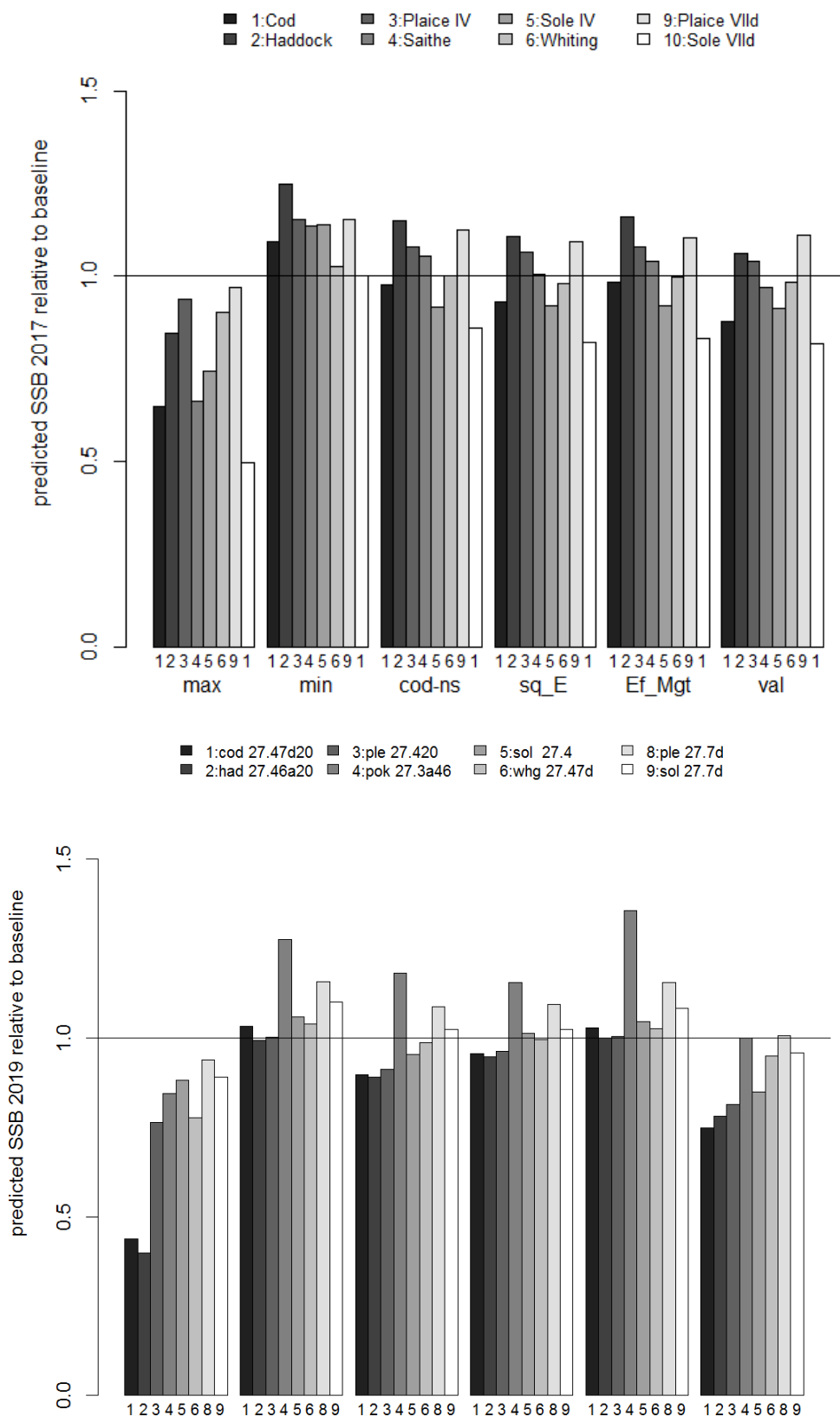


Figure 2.5.2.2.c Estimates of potential SSB at the start of 2017 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single stock advice (at the start of 2017). *Nephrops* are not included as abundance is not forecast from the mixed fisheries model.

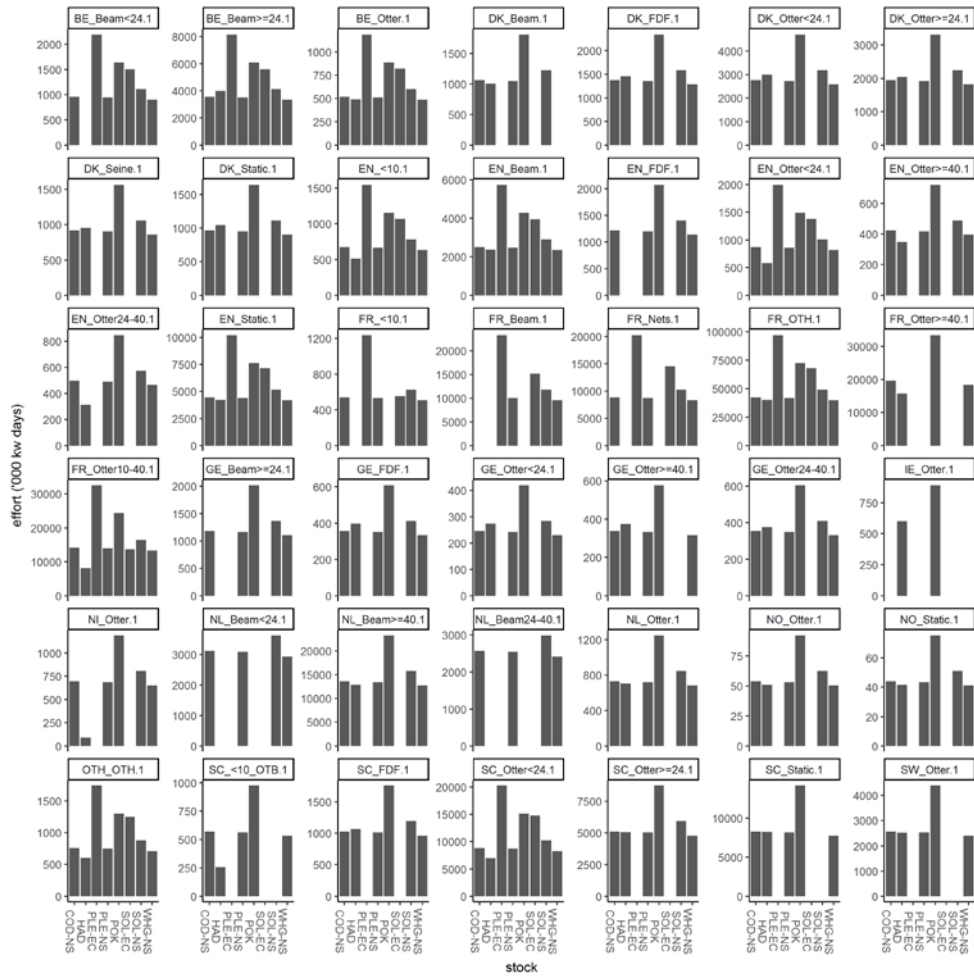


Figure 2.5.2.d TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual “quota share” (or partial target F) by stock in 2016 (baseline run). Finfish species.

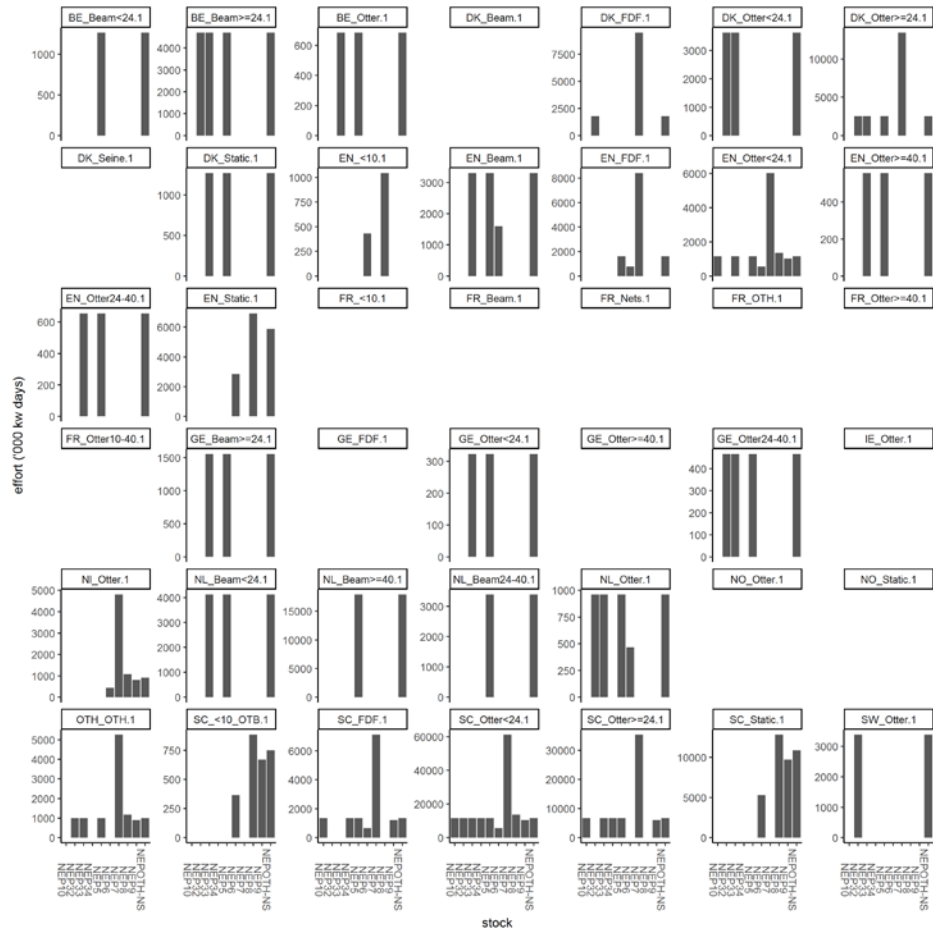


Figure 2.5.2.2.e TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual “quota share” (or partial target F) by stock in 2016 (baseline run). *Nephrops* FUs.



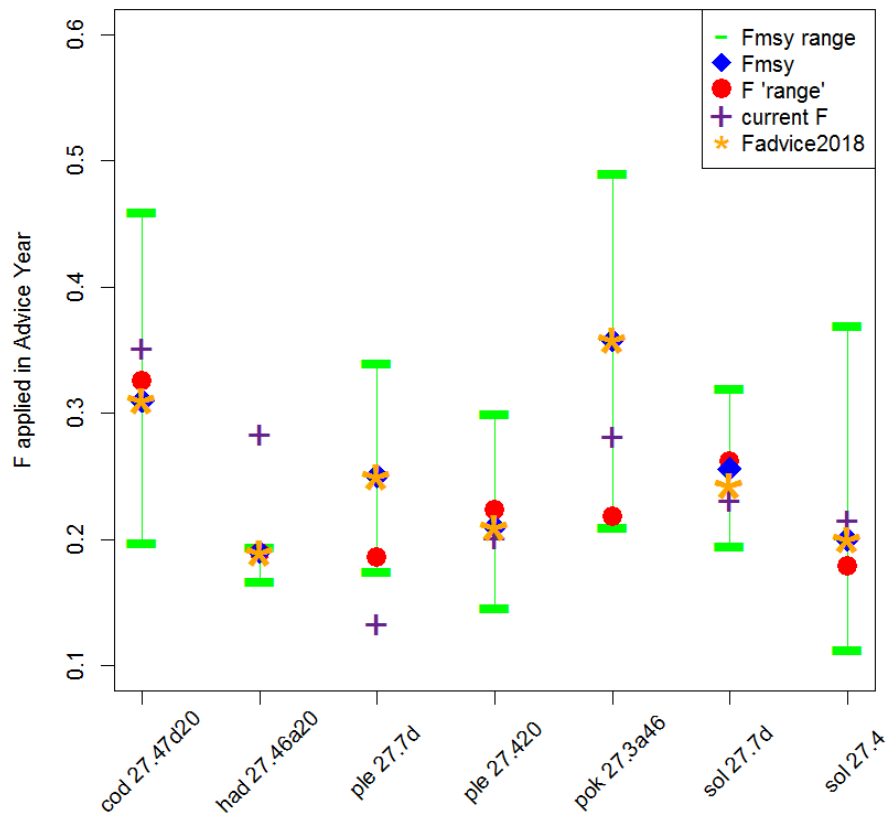


Figure 2.5.2.2.1.1 North Sea mixed-fisheries 2018 “range” fishing mortality within the  $F_{MSY}$  range, compared with  $F_{MSY}$ , current F (F in 2016), and F in the single stock advice for 2018. The “range” F is the one giving the lowest difference in tonnage between the “Max” and the “Min” scenario across all stocks and fleets.

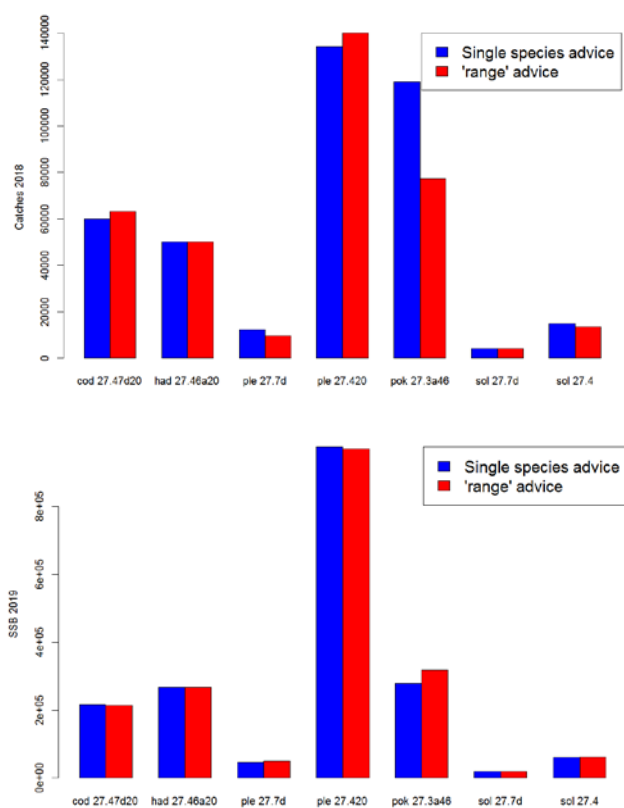


Figure 2.5.2.1.2 Comparison of the outcomes in terms of total catches in 2018 (top) and SSB in 2019 (bottom) between the  $F_{MSY}$ -based single stock advice and the  $F_{range}$ -based forecast.

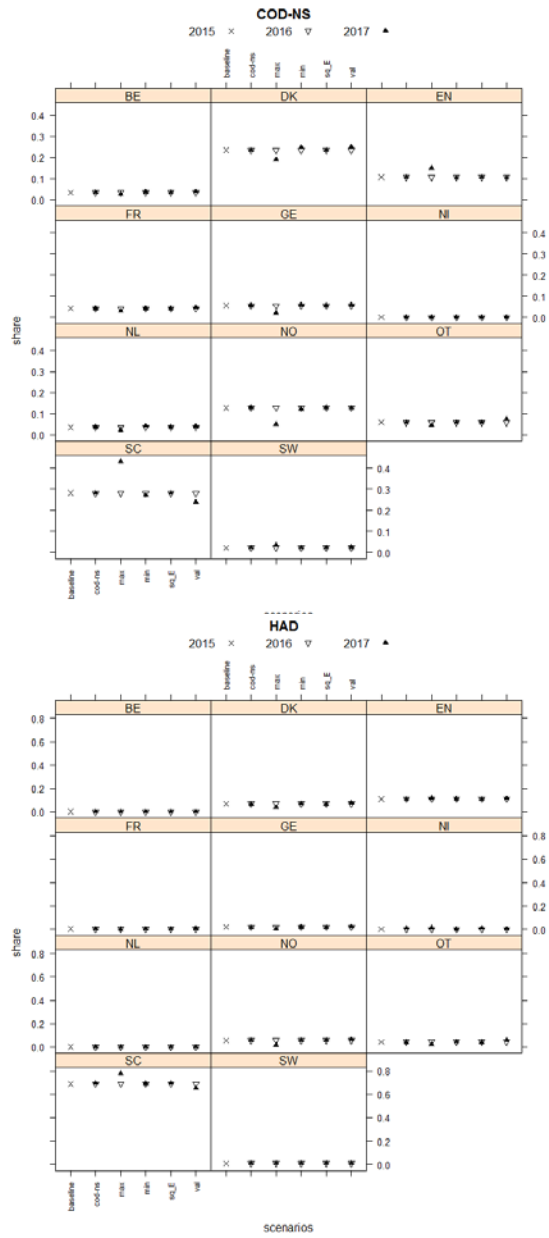


Figure 2.5.2.2.2 Test for relative stability. Changes of relative share of species' landings by country in 2016 and 2017 compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

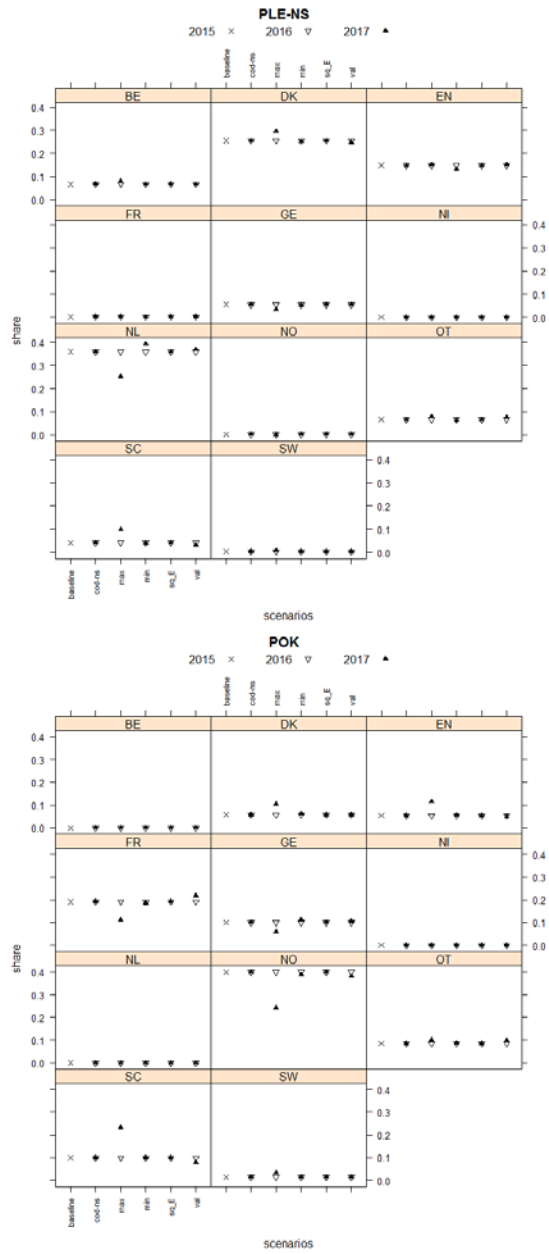


Figure 2.5.2.2.2 (cont) Test for relative stability. Changes of relative share of species' landings by country in 2016 and 2017 compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

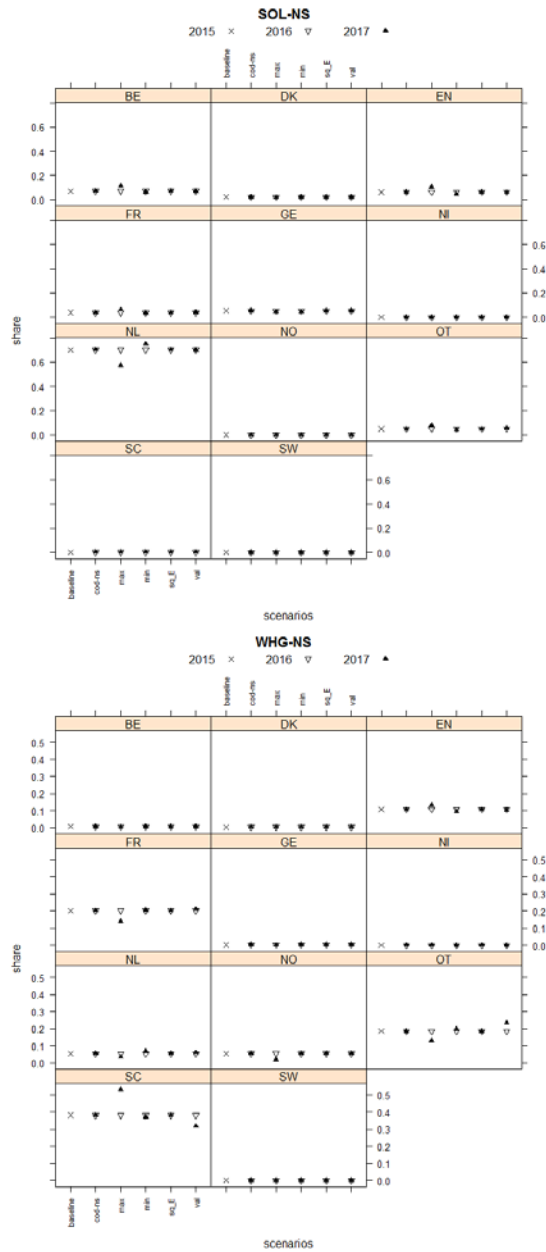


Figure 2.5.2.2.2 (cont) Test for relative stability. Changes of relative share of species' landings by country in 2016 and 2017 compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

## 3 Celtic Sea

### 3.1 Background

Fisheries in the Celtic Sea are highly mixed, targeting a range of species with different gears. Otter trawl fisheries take place for mixed gadoids (cod, haddock, and whiting), *Nephrops*, hake, anglerfishes, megrim, rays as well as cephalopods (cuttlefish and squid). Beam trawl fisheries target flatfish (plaice, sole, turbot), anglerfishes, megrim and cephalopods (cuttlefish and squid) while net fisheries target flatfish, hake, pollack, cod, anglerfishes as well as some crustacean species. Beam trawling occurs for flatfish (in 7.e and 7.fg) and rays (7.f). The fisheries are mainly prosecuted by French, Irish, and English vessels with additional Belgian beam trawl fisheries and Spanish trawl and net fisheries along the shelf edge (7.hjk).

The mixed gadoid fishery predominately takes place in ICES areas 7.f and 7.g with these areas responsible for > 75% of the landings of each cod, haddock and whiting. Landings are predominately by French and Irish vessels, though UK vessels also take significant landings of these species.

#### 3.1.1 Management measures


ICES advice in 2017 is given in terms of MSY for most Celtic Sea stocks. There are no single-species or mixed fisheries management plans for the gadoid stocks in the Celtic Sea. There are two single species plans relevant to the fisheries; a recovery plan for hake (Council Regulation (EC) No 811/2004) which implements a Total Allowable Catch (TAC) annually based on a defined Harvest Control Rule (HCR) and a management plan with both a HCR and effort management element for sole in the Western channel (7.e; Council Regulation (EC) No 509/2007). There are also a number of effort, technical and area closure measures in place summarised below.

The western waters regulation (Council Regulation (EC) No 1954/2003) implements an effort ceiling for  $\geq 15$  m vessels fishing for demersal species in Subarea 7 with additional effort ceiling specifications for an area to the South and West of Ireland known as the 'Biologically Sensitive Area' for vessels  $\geq 10$  m.

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, incorporation of a square mesh panel (SMP), and minimum mesh size in the cod end dependent on the target composition and/or area. Technical measures for the recovery of the stock of hake which includes subarea 7. Commission regulation (EC) No 1162/2001, commission regulation (EC) No 2062/2001, and commission regulation (EC) No 494/2002. The most recent of which relates to incorporation of the SMP detailed in commission implementing regulation (EU) No 737/2012 of 14 August 2012. Below is a summary of such measures produced by BIM of Ireland.

Mesh size (mm)	VII (Celtic Sea & West of Ireland)									
	Area VII Outside restricted areas				Celtic Sea Protection Zone				HAKE BOX	
	70-79	80-89	90-99	100+	70-79	80-89	90-99	100+	100	100+
Twine thickness	4mm double or single 6mm									
Headline Panel (mm) (Beam Trawlers see footnote 1)	-	-	-	-	-	-	-	-	-	-
Square mesh panel (mm)	80	-	-	-	120	120	120	120	120	-
Maximum number of meshes in codend circumference	120	120	100	100	120	120	100	100	100	100
Catch Composition	Either - Or									
Maximum % of cod allowed. (Council Reg 72/2016)	-	-	-	-	-	-	-	-	-	-
Maximum % cod, haddock, saithe allowed	-	-	30	-	-	-	30	-	-	-
Maximum % of hake allowed	20	20	20	-	20	20	20	-	-	-
Minimum % of saithe required	-	-	-	-	-	-	-	-	-	-
Minimum % of Nephrops required	35	30	-	-	35	30	-	-	-	-
Minimum % of Annex I List (see footnotes)	-	-	70 <sup>2</sup>	-	-	-	70 <sup>2</sup>	-	-	-
Minimum % of haddock, hake, whiting, megrim, monkfish, rays, saithe and Nephrops	-	-	-	-	-	-	-	-	-	-

Technical measures for the recovery of the stock of hake in ICES sub-areas III, IV, V, VI and VII and ICES divisions VIII a, b, d, e. COMMISSION REGULATION (EC) No 1162/2001. COMMISSION REGULATION (EC) No 2602/2001. COMMISSION REGULATION (EC) No 494/2002. COMMISSION IMPLEMENTING REGULATION (EU) 737/2012, 2015/741



2. Sole, plaice, megrim, whiting, brill, white pollack, lemon sole, dogfish, witch, John Dory, Queen scallop, monkfish, rays, turbot, grenadiers

6. Vessels using a codend mesh size between 70 and 119mm whose catch in any fishing trip east of 8°W comprises at least 55% whiting may use a square mesh panel of at least 100mm provided the trawl or seine is of a single mesh size larger than 100mm. Specific authorisation from the Member State must have been issued before going to sea.

Since 2005, three ICES rectangles (30E4, 31E4, and 32E3) have been closed during the first quarter (Council Regulations 27/2005, 51/2006, and 41/2007, 40/2008 and 43/2009) known as the Trevoise closure, with the objective of reducing fishing mortality on cod. A second area closure is in place to reduce fishing mortality on *Nephrops* within FU16, the Porcupine bank fishery. This currently month long closure in May (Council Regulation (EU) No 43/2014) has been in operation since 2009.

As of 1 January 2016 a European demersal species landings obligation was introduced (Commission Delegated Regulation (EU) 2015/2438). This regulation prevents the discarding of certain species on a fishery by fishery approach. Within the Celtic Sea the regulation applies to the below fisheries:

Fishery	Area	Gear	Landing obligation applies to:
Cod, haddock, whiting, saithe	7.b,c,e,f-k	Trawls & seines	All catches of whiting where total landings per vessel of all species in 2014 and 2015 consisted of more than 20% of the following gadoids: cod, haddock, whiting and saithe combined.
Nephrops	7	Trawls, seines, pots, traps, & creels	All catches of Norway lobster where the total landings per vessel of all species in 2014 and 2015 consisted of more than 20% of Norway lobster
Hake	6, 7, & EU 5.b	Trawls & seines	All catches of hake where the total landings per vessel of all species in 2014 and 2015 consisted of more than 20% of the hake.
Hake	6, 7, & EU 5.b	All gill nets	All catches of hake
Hake	6, 7, & EU 5.b	All long lines	All catches of hake
Pollack	7.d, 7.e	All trammel nets & gill nets	All catches of pollack
Sole ( <i>solea solea</i> )	7.b,c,f-k	All beam trawls	All catches of common sole where the total landings per vessel of all species in 2014 and 2015 consisted of more than 5% of common sole
Sole ( <i>solea solea</i> )	7.b,c,f-k	All trammel nets & gill nets	All catches of sole

## 3.2 Fcube

### 3.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.*, 2007; [www.flr-project.org](http://www.flr-project.org); FLCore 2.5.2, FLFleet 2.5.2, FLAssess 2.5.2, Flash 2.5.2) running with R3.2.1 (R Development Core Team, 2015). All forecasts were projected using the same  `fwd()` function in the Flash Package. The Fcube method is developed as a stand-alone script using FLR objects as inputs and outputs.

Software used in the single species assessments and forecasts was as outlined in the text table below.

STOCK	ASSESSMENT	FORECAST
Cod 7.e-k	Age-bases analytical assessment (FLR 2.x FLXSA)	FLR STF
Haddock 7.bc,e-k	ASAP (Age Structured Assessment Programme; NOAA toolbox)	FLR STF
Whiting 7.bc,e-k	Age-based analytical assessment (XSA)	FLR STF

### 3.2.2 Scenarios

The Fcube model has been presented and described in Ulrich *et al.* (2008; 2011). Brief details are presented below and a summary of the methodology is incorporated in the Celtic Sea Mixed Fisheries Annex (see Annex 4).

The basis of the model is to estimate the potential future levels of effort by a fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

In 2017, single-species ICES advice was given according to MSY approach for all three stocks. The basis for each single stock advice was retained in the current mixed-fisheries framework.

Prior to 2009, precursors to WGMIXFISH compiled age-disaggregated data over a large number of categories. Analyses in 2008 highlighted that the age composition of landings showed distinct differences to that supplied to the single species stock assessment working group (WGNSSK) and therefore WGMIXFISH runs projections on the basis of total landings and discards alone.

The following eight options (or scenarios) were included in the advice:

- 7) **range**: This range scenario is where the risks of TAC mismatch in 2018 are minimised by setting target fishing levels within the  $F_{MSY}$  ranges for stocks where such ranges exist and returns a fishing mortality by stock which, if used for setting single stock fishing opportunities for 2018, may reduce the gap between the most and least restrictive TACs, thus reducing the risks of quota over- and undershoot.
- 8) **max**: Fishing stops when all stocks considered have been caught up to the ICES single stock advice. This option causes overfishing of the single stock advice possibilities of most stocks.



- 9) **min**: Fishing stops when the catch for any one of the stocks considered meets the single stock advice. This option is the most precautionary option, causing under-utilisation of the single stock advice possibilities of other stocks.
- 10) **cod**: All fleets set their effort corresponding to that required to land their quota share of cod, regardless of other catches.
- 11) **had**: All fleets set their effort corresponding to that required to land their quota share of haddock, regardless of other catches.
- 12) **whg**: All fleets set their effort corresponding to that required to land their quota share of Whiting, regardless of other catches.
- 13) **sq\_E**: The effort is set equal to the effort in the most recently recorded year for which landings and discard data are available.
- 14) **Val**: 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.

A preliminary run was undertaken including the *Nephrops* stocks (FUs 16, 17, 18, 19, 20–21 and 22) in the Celtic Sea in the mixed fisheries forecasts. This was not completed for the advice sheet, but as a separate proof-of-concept. A complicating factor when incorporating *Nephrops* is the fact that the species is found in a number of distinct areas or functional units (FU), only some of which receive an abundance estimate (necessary to calculate a catchability). Further, for the Celtic Sea stocks, the TAC covers the entire ICES Area 7, including 7.a where most of the TAC landings are taken (but is not covered by the mixed fisheries advice). The details of the approach taken are in Section 3.6.

### 3.3 Stock input data and recent trends

#### 3.3.1 Stocks

##### 3.3.1.1 Data

The assessment data for the different stocks were taken from ICES WGCSE (ICES, 2017). All stock inputs formatted as FLStock objects were directly provided to WGMIXFISH by the respective stock coordinators, and this eased greatly the quality of the process of collecting stock data.

##### 3.3.1.2 Trends and advice

**This advice is drafted by the WGCSE-2017 before considerations by ACOM.**

Recent trends are described on a stock-by-stock basis in ICES (2017), and latest advice by stock is available on the ICES website. In order to give an overview of the Celtic Sea demersal stocks considered for mixed fisheries analysis, this information is summarized below. Table 3.3.1.2 list the final advised TACs for 2018 and forecast SSBs in 2018.

Table 3.3.1.2.1a Analytical stocks

COD	7. e-k	Fishing pressure			Stock size			ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 3454 tonnes. If discard rates do not change from the average of the last 3 years (2014–2016), this implies landings of no more than 3099 tonnes	The spawning-stock biomass (SSB) has increased since 2014 but remains below $B_{lim}$ in 2017. Fishing mortality has been decreasing since 2014 but is still above $F_{MSY}$ in 2016. Recruitment was high in 2014 and very weak in 2015 (smallest recruitment of the time series). Recruitment in 2016 is just below average.			
		2014	2015	2016	2015	2016	2017					
COD	7. e-k	Maximum sustainable yield	$F_{MSY}$	✗	✗	✗	Above	MSY $B_{trigger}$	✗	✗	✗	Below trigger
		Precautionary approach	$F_{pa}$ / $F_{lim}$	✗	⦿	✓	Harvested sustainably	$B_{pa}$ / $B_{lim}$	✗	✗	✗	Reduced reproductive capacity
		Management plan	$F_{MGT}$	—	—	—	Not applicable	$B_{MGT}$	—	—	—	Not applicable
HAD	7.bc,e-k	Maximum Sustainable Yield	$F_{MSY}$	✗	✗	✗	Above	MSY $B_{trigger}$	✓	✓	✓	Above trigger
		Precautionary Approach	$F_{pa}$ / $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ / $B_{lim}$	✓	✓	✓	Full reproductive capacity
		Management plan	$F_{MGT}$	—	—	—	Not applicable	$B_{MGT}$	—	—	—	Not applicable
WHG	7.bc,e-k	Maximum Sustainable Yield	$F_{MSY}$	✓	✓	✓	Appropriate	MSY $B_{trigger}$	✓	✓	✓	Above trigger
		Precautionary Approach	$F_{pa}$ / $F_{lim}$	✓	✓	✓	Harvested sustainably	$B_{pa}$ / $B_{lim}$	✓	✓	✓	Full reproductive capacity
		Management plan	$F_{MGT}$	—	—	—	Not applicable	$B_{MGT}$	—	—	—	Not applicable



### 3.4 Fleets and métiers

#### 3.4.1 Catch and effort Data

Landings and effort data were requested consistent with the definition of DCF métiers and with data submitted to InterCatch (though with additional vessel length disaggregation), as specified by a joint WGCSE/WGMIXFISH data call.

The WGMIXFISH information was requested with the same DCF métier-based definitions as those to InterCatch, but separated into vessel length categories specified to match fleet segments from the STECF AER (Annual Economic Report) and provided directly as comma separated files.

Discard data were not requested by vessel length categories, as national observer sampling programmes do not distinguish between vessel lengths, so discard ratios for the various métiers aggregated across all vessel lengths could be extracted from InterCatch and applied to the landings of the corresponding métiers in the vessel length specific data. In the case of discard raising of Irish landings, the same proportion discards were applied to the gear irrespective of target species, consistent with the data submitted to InterCatch (and the single stock advice raising procedures).

Age distribution by métier and area, which is now available in InterCatch, was not integrated in the MIXFISH data, but ultimately it is the aim to include them in future. The relative size of catches of the stocks incorporated in the mixed fisheries projections is shown in Figure 3.4.1.a.

The final dataset extracted from InterCatch for use by WGCSE includes discards estimates (either imported or raised) for all stocks and métiers. These InterCatch estimates have been used to estimate a discard ratio by métier, which allows allocating discards for all WGMIXFISH fleets and métiers with matching names, such that;

$$d^* = \frac{Dl}{L}$$

Where  $d^*$  is the discard value for the métier used by Fcube,  $l$  is the weight of landings for the métier used by Fcube and  $L$  and  $D$  are the weights of landings and discards entered for the (vessel length aggregated) métier in InterCatch.

All discard estimates were retrieved from InterCatch and assigned to the same métiers within the WGMIXFISH csv files. However, this method relies on being able to match métier definitions between the two datasets. The conformity of métiers in MIXFISH and InterCatch was generally high and improving year after year, but it was still not possible to match a few métiers. It would be desirable for Member States to keep improving the consistency between data uploaded to InterCatch and data submitted to WGMIXFISH and this is expected to improve as the Celtic Sea mixed fisheries advice develops.

#### 3.4.2 Definitions of fleets and métiers

The procedure for defining the fleets and métiers in the model was similar to that applied in the North Sea. In summary:

- Fleets were defined by aggregating catch and effort across country, gear group (e.g. OTB\_DEF and OTB\_CRU combined) and vessel length (where applicable).

- Any fleet catching < 1% of any of the stocks included the analysis was binned into an “others” (“OTH”) fleet to reduce the dimensions of the model.
- Effort and catch files were matched to ensure consistency, métiers with effort and no catch were aggregated to the OTH fleet.
- Within a fleet, a métier was defined as a combination of gear, target species (e.g. demersal fish, DEF, or crustaceans, CRU) and ICES subarea (e.g. 7.b).
  - Similar aggregating procedure as for the fleets was performed, where any métier catching < 1% of a métiers catch of each stock was aggregated into an “OTH” métier.

The final data used contained 14 national fleets (plus an OTH fleet) from three countries, covering catch and effort for the years 2014 to 2016. These fleets engage in one to eight different métiers each, resulting in 59 combinations of country\*fleet\*métier\*area catching cod, haddock, and whiting (Table 3.4.2.a). The balance of catches of the stocks across gear categories is shown in Figure 3.4.1.b.

Fleet definitions in the final selection are summarised as follows:

- England: Beam trawling vessels 24–40m for demersal species; two otter trawl fleets separated by length (10–24m and 24–40m); a static gear fleet; and an English other fleet.
- France: Otter trawling vessels by vessel length (10–24m, 24–40m and “all” (other lengths, mostly < 10 m)); and a French other fleet containing for example passive fishing methods.
- Ireland: Beam trawling vessels distinguished by vessel length (10–24m and 24–40m); two otter trawl fleets, again by vessel length (10–24m, 24–40m); and an Irish other fleet (24–40m) containing for example gillnetting.

All the WGMIXFISH métiers for the Celtic Sea are defined as combinations of gear, target species (level 5; see table 3.4.2.a) and area (7.b, 7.c, 7.e, 7.f, 7.g, 7.h, 7.j, 7.k). The list of fleets, métiers with their catch (tonnes, all species) and effort are provided in Table 3.4.2.b.

As a crosscheck of the data, the total landings and discards across all fleets were compared to the values estimated from the single species stock assessments (Table 3.4.3 and Figure 3.4.2). Some landings may not be allocated to fleets, due to issues such as missing countries or areas or national landings with missing logbook information that cannot be allocated to a fleet. The landings coverage for all fish stocks is very high (above 95% of landings of each fish stock for each of the years 2014–2016 could be allocated to one of the fleets). To address the remaining small inconsistencies between fleet data used by WGMIXFISH and stock data, the differences between them were pooled into the “OTH” fleet (both landings and discards).

### 3.4.3 Trends

A series of tables and figures were produced to check the quality of the data once compiled into the final fleets object. Some are useful to show the relative importance of the fleets chosen in their effort and catches. Effort by fleet in absolute levels (Table 3.4.2; not presented in a figure due to short time series), effort share by métier and fleet (Figure 3.4.3.a) and landings by fleet and stock (Figure 3.4.3.b) are also included in this report.

## 3.5 Mixed fisheries forecasts

### 3.5.1 Description of scenarios

#### 3.5.1.1 Baseline Runs

The objectives of the single species stock baseline runs were to:

- 1) reproduce as closely as possible the single species advice produced by ACOM,  
and
- 2) act as the reference scenario for subsequent mixed fisheries analyses.

The various single stock forecasts presented by WGCSE are performed using different software and setups (see 3.2.1 above). However, for the purpose of the mixed-fisheries analyses, it is necessary to gather all forecasts into a single unified framework, which builds on the 'fwd()' method in FLR (Flash R add-on package). The same forecast settings as in WGCSE are used for each stock regarding weight-at-age, selectivity and recruitment, as well as assumptions on the  $F$  in the intermediate year and basis for advice (MSY approach).

Some differences can occur in the forecast calculations, (because of the diversity of single stock assessment methods used) and the WG always investigates in depth the reasons for potential discrepancies. Adjustments to the Fcube forecasts are made if necessary to minimize discrepancies to the largest extent possible.

The intention of the baseline runs was thus mainly to act as a check to ensure that the projections were set up correctly within the Fcube script, but these runs also have the incidental benefit of acting as a quality control check on the WGCSE projections themselves. As the forecast methods for Celtic Sea cod, haddock and whiting single stock advice are based on FLR fwd(), matching the forecasts for these stocks is relatively straight forward. Addition of stocks with more diverse assessment and forecasting methods in future will require consideration of how to integrate these stocks into the forecasts.

#### 3.5.1.2 Mixed fisheries runs

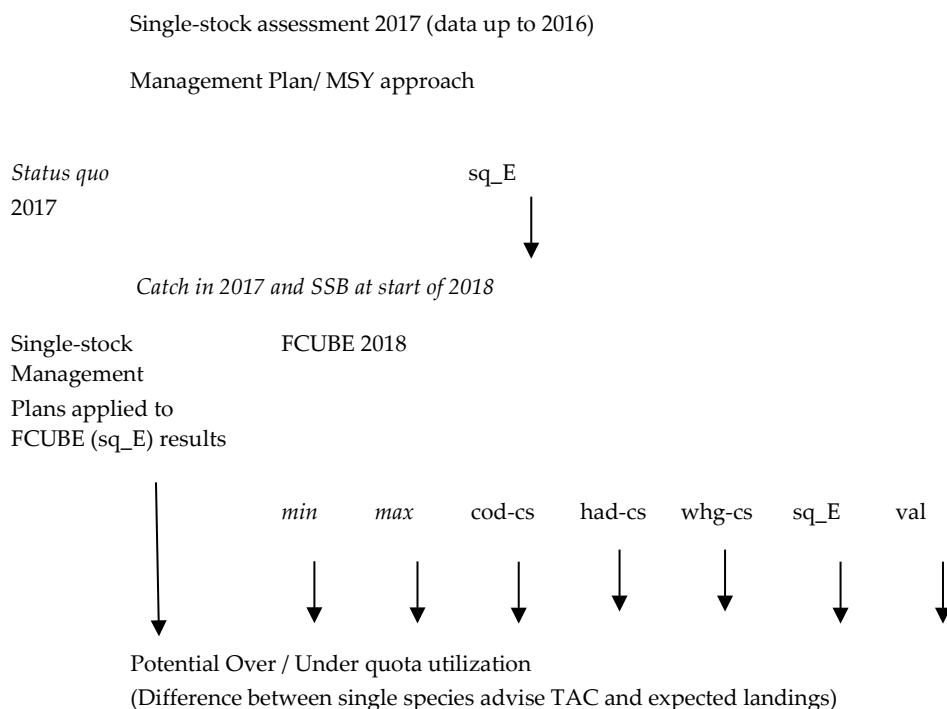
##### 3.5.1.2.1 Fcube analyses of the intermediate year (2017)

Last year the intermediate year forecast was skipped due to incompatibilities between the single stock forecasts (where an unscaled average  $F$  of the past 3 years was used for the status quo  $F$  assumption) and the Fcube *status quo* effort assumption, which is based on a single most-recent year. However, this year the single stock forecasts were changed to being based on a rescaled (2016) *status quo*  $F$ , therefore the group also returned to the application of a *status quo* effort assumption in the intermediate year for the Fcube forecasts. This results in the same catches,  $F$  and SSBs in the intermediate year Fcube forecast as the single stock forecasts and thus the same starting point for the TAC year results. It was considered that *status quo* effort was a more appropriate scenario than two successive Fcube scenario years as it is consistent with recent observed trends in fishing effort and assumptions in the single stock advice (see next Section).

### 3.5.1.2.2 Fcube analyses for the TAC year (2018)

Seven TAC year scenarios were run, as outlined in section 3.2.2, in addition to the 'range' scenario.

In summary, the Fcube runs followed the scheme below:



## 3.5.2 Results of Fcube runs

### 3.5.2.1 Baseline run

The rationale behind the single species baseline runs is given in Section 3.5.1.1. Table 3.5.2.1.a contains the outputs from these runs. Figure 3.5.2.1.a also shows the required change in fishing mortality for the different stocks from 2016 through the intermediate year and into the TAC year. It can be seen from Figure 3.5.2.1.a that haddock requires the biggest reduction in  $F$ , indicating the potential for it to be the 'choke' species for the fisheries that catch haddock. The change in  $F$  on haddock from 2016 to 2018 implies a change in fishing effort (from  $F = 0.674$  in 2016 to  $F = 0.40$  in 2018) of  $-41\%$  which is a level of fishing effort lower than to catch the other stocks. Conversely, whiting  $F$  in 2016 ( $F = 0.43$ ) is below  $F_{MSY}$  ( $0.52$ ) requires which implies a change in fishing effort in 2018 of around  $+21\%$  to catch the quota, higher effort than required to catch haddock or cod.

No issues were encountered in replicating the single species advice. The results from these baseline runs are compared with the results from the corresponding ICES runs in Tables 3.5.2.1.b and summarized at Figure 3.5.2.1.b. The replicated forecast for all stocks were almost identical to the single stock advice.

### 3.5.2.2 Mixed fisheries analyses

#### 3.5.2.2.1 Intermediate year baseline

The full overview of the Fcube projections to 2018 is presented in Table 3.5.2.2.a and Figures 3.5.2.2.a and 3.5.2.2.b. The results for 2018 can be compared to each other as in a single-species option table. For ease of comparison, a table with the landings relative to the single stock advice is also presented on Table 3.5.2.2.b.

The baseline run for **cod**, which follows the single stock ICES advice, assumes landings of 3323 tonnes in 2017 and 3429 tonnes in 2018. The resulting SSB in 2019 is estimated to be 12 009 tonnes. WGMIXFISH assumed *status quo* *F* in 2017.

The baseline run for **haddock**, which follows the single stock ICES advice, assumes catches of 14 996 tonnes in 2017 and 8393 tonnes in 2018. The resulting SSB in 2019 is estimated to be 24 919 tonnes. WGMIXFISH assumed *status quo* *F* in 2017.

The baseline run for **whiting**, which follows the single stock ICES advice, assumes catches of 20 898 tonnes in 2017 and 19 548 tonnes in 2018. The resulting SSB in 2019 is estimated to be 46 584 tonnes. WGMIXFISH assumed *status quo* *F* in 2017.

#### 3.5.2.2.2 TAC year Fcube runs

The outcomes of the “minimum” and “maximum” scenarios are driven by which of the stocks will be most and least limiting for each individual fleet (Figure 3.5.2.2.a). In the “Minimum” scenario, the most limiting stocks are haddock and cod for fleets representing 64% and 24% of the effort in 2016 respectively. In the “Maximum” scenario, the least limiting stock is whiting and cod for fleets representing 88%, and 12% of the effort in 2016, respectively. The maximum scenario is close to the “whiting” scenario.

The min scenario assumes that fleets would stop fishing when their first quota share is exhausted, regardless of the actual importance of this quota share, thus leading to a distorted perception of plausible fleet behaviour. It is included to demonstrate the lower bound of potential fleet effort and stock catches. Similarly, the max scenario demonstrates the upper bound of potential fleet effort and stock catches but, through assuming all fleets continue fishing until all their quotas are exhausted irrespective of the economic viability of such actions, this is also considered a scenario with low plausibility. The **had** and **cod** scenarios do, however, give similar results to the **min** scenario (Table 3.5.2.2.b and Figure 2.5.2.2.a) because haddock is the most limiting species for a high percentage of fleet effort, followed by cod.

Other scenarios represent intermediate plausible scenarios reflecting basic current management measures as well as the *status quo* and value based options. ICES WGMIXFISH has not conducted work to assess which of these scenarios may represent the most likely outcome, but hindcasting projections should be investigated as those previously made for the North Sea runs (Ulrich *et al.*, 2011).

The anticipated SSBs in 2019 of the Fcube scenarios are shown in Figure 3.5.2.2.b. Haddock does not achieve the single species SSB predicted in any of the scenarios. Only the **min** scenario results in SSBs slightly higher than the single stock forecasts for cod. While whiting is either the same (**max** and **whg**) or higher in all scenarios.

Figure 3.5.2.2.c shows the level of effort required by each fleet to catch their quota share of the single species TAC advice for each stock. This highlights the much lower effort required to fulfil the haddock quota in 2018 than for cod, which is again much lower than that for whiting highlighting the incompatibility of the effort levels (and quotas) required to catch each of the three stocks in 2018.



### 3.5.2.2.3 Optimised range option

A “range” scenario is presented (Figure 5.3.2.2.e), where the potential TAC mismatch in 2018 are minimised by setting target fishing levels within the  $F_{MSY}$  ranges. This scenario returns a fishing mortality by stock which, if used for setting single stock fishing opportunities for 2018, may reduce the gap between the most and least restrictive TACs, thus reducing the potential quota over- and undershoot. The ‘range’ scenario suggests that TAC for cod is set slightly higher than the single stock advice, the haddock TAC is set between the  $F_{MSY}$  estimate and the upper end of the range and the TAC for whiting set lower than the single stock advice, at the bottom of its range.

### 3.5.2.2.4 Relative stability

Relative stability as such is not directly included as an input to the model. Instead, an assumption that the relative landings share of the fleets are constant is used as a proxy, and in the scenarios above, this input is calculated as the average landing share by fleet and stock in 2015. As a crosscheck, the landings by national fleets were summed over nation for each scenario, and the share by country was compared with this initial input (Figure 3.5.2.2.2). The results show some deviations across all scenarios which arise because (under the assumption of a full discard ban), fleets with a small share of a stock but high discard rate have their fishing activity limited by that stock, resulting in underutilization of their target stock(s) This can translate to underutilization at the national level, as seen by the change in landings share of the stocks by EU Member States in the mixed fisheries forecasts.

## 3.6 Incorporation of *Nephrops* in the Celtic Sea mixed fisheries advice

Investigations were continued to include the *Nephrops* FUs in the Celtic Sea mixed fisheries analysis as each FU has under-water television (UWTV) survey estimates of abundance, harvest rates, and MSY targets (WGMIXFISH-ADVICE Report, 2015). However, the two complicating factors remain which must be addressed prior to analysis;

- i) The latest abundance estimates (and single stock advice sheets) are produced following the summer UWTV surveys, after WGMIXFISH meets.
- ii) A single *Nephrops* TAC applies to the entire Area 7., which includes two FUs in the Irish Sea (subarea 7.a, FUs 15 and 16), which are outside the area the Celtic Sea demersal fisheries operate, but contribute to ~60% of the landings of the Area 7. TAC.

The issues were treated as follows:

- i) The UWTV abundance estimates and stock weights from surveys undertaken in 2016 were used for abundance in the forecasts in 2017 and 2018. Landings weights, discard weights and discard ratios from 2015 (from advice delivered in 2016), combined with preliminary landings (tonnage) estimates for 2016 were used to estimate landings and discard numbers in 2016, and calculate a harvest ratio in 2016.

The same target harvest ratios from the advice in 2016 (for quotas in 2017) were used for the TAC year forecasts (2018). The assumption of constant abundance in 2016, 2017 and 2018 is the same assumption as used for the North Sea advice where UWTV surveys in 2017 are not incorporated in the 2018 advice.

- ii ) The Celtic Sea Nephrops TAC component (ICES Area 7 excluding 7.a) was assumed to be equal to the split of the landings between the two areas. Total Area 7 landings in 2016 were 14 136, with 232 t from FU 14 and 7008 t from FU 15, leaving 6895 t from Area 7– 7.a (49% of the overall Area 7 landings). For the 2017 TAC, this implied 12 171 t (Area 7 TAC = 25 356 t \* 0.48).
- iii ) In addition, in many instances there was no combined ICES area & FU landings data for the fleets, where there was no area it was assumed to be the dominant area of the FU in the métier definition.

Preliminary results are presented in Figure 3.6. *Nephrops* landings are under the pseudo-TAC in all scenarios, indicating they are not limiting in 2018 but may drive effort above the single stock advice for the demersal stocks.

Table 3.3.1.2 Celtic Sea. Summary of the 2018 landings and target Fs/harvest ratios, resulting from the Advice Approaches considered by ICES. Target Fs are left justified; harvest ratios are right justified. Where a stock/Functional Unit does not have a management plan the landings follow ICES advice.

SPECIES	AGREED TAC (SUMMED TACS) 2017	TOTAL CATCH-ADVICE FOR 2018	WANTED CATCH-ADVICE FOR 2018	F/HARVEST RATIO FOR 2017	F/ HARVEST RATIO FOR 2018	SSB 2018	SSB 2019	RATIONAL
Cod 7.e-k	2 830**	3 464	3099	0.44	0.30	8755	11 982	MSY
Haddock 7.bc, 7.e-k	7 751^	8 393	5 936	0.58	0.42	20 257	24 919	MSY
Whiting 7.bc, 7.e-k	27 500*	19 548	13 841	0.43	0.524	48 763	46 584	MSY
<i>Nephrops</i> FU16	3 100			6.2				MSY
<i>Nephrops</i> FU17	25 356 ***			6.0				MSY
<i>Nephrops</i> FU19	25 356 ***			8.6				MSY
<i>Nephrops</i> FU20-21	25 356 ***			6.0				Conservative
<i>Nephrops</i> FU22	25 356 ***			11.2				MSY
<i>Nephrops</i> FU18+7.OTH	25 356 ***							na

\*\* Applies to Divisions 7.b,c,e-k, Subareas 7.I, 9, and 10, and EU waters of CECAF 34.1.1.

^ Applies to Divisions 7.b-k and Subareas 7.I, 9, and 10.

\* TAC covers Subarea 7. (except Division 7.a).

\*\*\*TAC for whole of Subarea 7.

**Table 3.4.2.a Celtic Sea. Métiers consistent with DCF métier level 5. Mixed-fisheries métiers are further disaggregated into areas: 7.b, 7.c, 7.e, 7.f, 7.g, 7.h, 7.j and 7.k.**

GEAR	TARGET SPECIES	MIXED-FISHERIES MÉTIERS (PLUS AREA)
Gillnets	Demersal fish	GNS_DEF
Otter trawls	Crustaceans	OTB_CRU
Otter trawls	Demersal fish	OTB_DEF
Seines	Demersal fish	SSC_DEF
Beam trawls	Demersal fish	TBB_DEF
Twin otter trawls	Crustaceans	OTT_CRU
Twin otter trawls	Demersal fish	OTT_DEF
Other gears	Any	MIS_MIS / OTH

**Table 3.4.2.b Celtic Sea. Final fleet and métier categories used in the mixed fishery analysis.**

Fleet	Metier	2014		2015		2016	
		Catch	Effort	Catch	Effort	Catch	Effort
EN_Beam_24<40m	TBB_DEF_27.7.e	391.56	1572.79	427.69	1615.58	449.09	1987.12
EN_Other_all	MIS_MIS_27.7.e	493.52	4043.04	611.28	4328.03	574.01	4607.32
	OTH	1.94	2429.32	24.58	2719.90	2.29	2488.17
EN_Otter_10<24m	OTB_DEF_27.7.e	2051.99	1743.07	1915.14	1760.88	2013.63	1755.10
	OTH	0.06	163.43	40.48	273.17	23.80	503.54
EN_Otter_24<40m	OTB_DEF_27.7.b	2.55	78.73	0.80	161.80	1.66	239.56
	OTB_DEF_27.7.e	103.31	16.72	68.53	11.80	61.80	1.29
	OTB_DEF_27.7.g	15.92	71.47	16.85	80.37	9.57	103.46
	OTB_DEF_27.7.j	114.36	1169.71	33.23	944.09	29.11	855.77
	OTH	1.41	395.38	0.04	508.13	0.12	488.30
EN_Static_all	GNS_DEF_27.7.e	283.01	537.13	241.46	403.68	301.56	504.61
	GTR_DEF_27.7.e	17.91	48.96	13.06	73.91	9.77	33.18
	FR_Other_all	422.18	190336.81	415.13	179135.94	473.84	159433.95
	MIS_MIS_27.7.e	273.03	130673.49	214.36	113260.01	362.83	109835.11
	MIS_MIS_27.7.g	59.28	3688.17	63.93	3382.78	25.05	3082.73
	MIS_MIS_27.7.h	53.54	21563.00	113.12	21466.80	26.70	18218.45
	MIS_MIS_27.7.j	23.16	18541.96	13.41	29144.04	47.54	18069.89
FR_Otter_10<24m	OTH	13.16	15870.20	10.31	11882.31	11.70	10227.78
	OTB_DEF_27.7.e	2761.08	51484.52	4564.42	59544.36	4677.96	57860.64
	OTB_DEF_27.7.f	1993.65	7525.08	1241.57	5890.11	867.31	6827.24
	OTB_DEF_27.7.g	1343.06	5132.16	376.27	2898.46	805.84	6729.56
	OTB_DEF_27.7.h	1372.70	13135.66	1850.77	16557.29	1375.82	15605.24
FR_Otter_24<40m	OTH	1.00	1939.29	34.96	1953.83	17.29	2679.82
	OTB_DEF_27.7.b	480.51	6612.45	411.59	6947.76	423.30	7067.90
	OTB_DEF_27.7.e	2163.40	34070.19	2948.65	36648.46	2458.28	32127.61
	OTB_DEF_27.7.f	2663.97	6589.90	922.31	3294.00	820.61	4110.10
	OTB_DEF_27.7.g	2835.33	6936.93	1381.95	5037.16	1300.70	6352.60

Fleet	Metier	2014		2015		2016	
		Catch	Effort	Catch	Effort	Catch	Effort
	OTB_DEF_27.7.h	2436.99	22729.98	3652.42	25849.19	3690.23	26027.14
	OTB_DEF_27.7.j	606.45	20845.65	763.24	25221.38	720.75	24570.35
	OTH	257.20	7217.48	157.77	6947.91	109.20	7410.32
FR_Otter_all	OTH	515.07	5280.21	189.13	3148.92	137.30	2729.55
	OTT_CRU_27.7.g	235.57	2614.67	260.88	2436.86	263.77	2299.91
	OTT_CRU_27.7.h	68.25	1397.82	57.78	1043.83	135.97	1343.11
	OTT_DEF_27.7.g	2183.70	10211.05	1453.17	8320.11	1288.71	9500.65
	OTT_DEF_27.7.h	2008.20	27073.79	2607.73	30575.71	1866.79	29916.30
	OTT_DEF_27.7.j	115.13	5471.37	99.89	4691.52	108.73	5324.72
	SSC_DEF_27.7.e	75.14	2017.34	92.40	2061.83	58.66	1538.45
	SSC_DEF_27.7.g	266.90	962.80	257.20	743.82	221.91	513.91
IE_Beam_10<24m	OTH	11.57	16.35	0.00	0.00	0.00	0.00
	TBB_DEF_27.7.g	298.30	489.32	297.09	497.92	293.98	500.56
IE_Beam_24<40m	OTH	4.14	16.28	3.50	16.28	4.13	4.42
	TBB_DEF_27.7.g	518.12	1526.42	497.70	1606.10	559.13	1799.61
IE_Other_24<40m	MIS_MIS_27.7.b	0.00	0.00	0.00	0.00	21.27	207.54
	MIS_MIS_27.7.g	0.00	0.00	200.55	159.59	669.40	174.84
	MIS_MIS_27.7.j	0.00	0.00	1.37	293.39	47.72	145.91
IE_Otter_10<24m	OTB_CRU_27.7.g	427.74	1847.47	464.40	2055.05	415.71	2272.08
	OTB_DEF_27.7.g	5022.66	4089.73	4571.92	4086.11	5444.81	4156.15
	OTB_DEF_27.7.j	2090.68	2003.46	906.06	1699.98	944.09	1957.54
	OTH	791.15	2996.07	341.18	2703.44	279.77	3208.17
	SSC_DEF_27.7.g	2188.47	635.10	1719.43	514.12	1759.69	620.23
	SSC_DEF_27.7.j	567.76	237.26	436.95	278.75	417.61	277.39
IE_Otter_24<40m	OTB_CRU_27.7.g	141.17	917.69	180.20	1037.92	181.18	1241.75
	OTB_DEF_27.7.b	350.97	640.09	482.49	578.62	257.70	462.13
	OTB_DEF_27.7.g	2329.98	1030.61	2497.31	1367.55	3131.58	1644.54
	OTB_DEF_27.7.j	248.44	761.87	176.11	613.79	276.69	591.45
	OTH	58.19	3395.03	66.19	3665.21	50.90	3702.39
	SSC_DEF_27.7.b	388.67	71.18	380.70	127.64	219.59	76.87
	SSC_DEF_27.7.g	1003.97	252.85	990.98	201.73	1135.28	268.35
	SSC_DEF_27.7.j	829.13	367.01	609.72	268.53	496.08	265.99
OTH_OTH	OTH	1578.18	1000.00	1368.58	1000.00	1781.33	1000.00

**Table 3.4.3 Proportion of the stocks total landings and discards (from WGCSE) covered by the MIXFISH fleets. A ratio > 1 means that the catch information in MIXFISH is higher than the information used by WGCSE.**

YEAR	STOCK	WG. LAND	MIX. LAND	LAND. DIFF	WG. DISC	MIX. DISC	DISC. DIFF	RATIO.L AND	RATIO. DISC
2014	COD-CS	3879	3869.855	-9.14	0	881.8	881.79	1	Inf
2015	COD-CS	4154	4015.114	-138.89	0	895.2	895.18	0.97	Inf
2016	COD-CS	3299	3174.395	-124.61	0	566.2	566.21	0.96	Inf
2014	HAD-CS	9854	9635.036	-218.96	3177	13524	10347.04	0.98	4.26
2015	HAD-CS	8545	8373.436	-171.56	6694	11682.1	4988.10	0.98	1.75
2016	HAD-CS	7594	7330.319	-263.68	10337	10392.9	55.92	0.97	1.01
2014	WHG-CS	12847	13122.44	275.44	3977	8724.2	4747.18	1.02	2.19
2015	WHG-CS	13174	13026.74	-147.26	6101	6444.6	343.59	0.99	1.06
2016	WHG-CS	15179	14999.66	-179.34	7278	7526.5	248.5	0.99	1.03

**Table 3.5.2.1.a Celtic Sea. Baseline run outputs from the Fcube FLR package.**

		COD-CS	HAD-CS	WHG-CS
2017	Fbar	0.44	0.58	0.43
	FmultVsF16	1	0.85	1
	landings	3323	14996	20898
	ssb	7140	32936	58288
2018	catch	3429	8393	19548
	Fbar	0.3	0.4	0.52
	FmultVsF16	0.68	0.6	1.22
	landings	3429	8393	19548
	ssb	8755	20257	48763
2019	ssb	12009	24919	46584

**Table 3.5.2.1.b Comparison between baseline run and ICES advice for finfish. Figures for 2017 compare results from the baseline run to the ICES intermediate year results. The baseline run uses the same assumptions for F in the intermediate year as the forecasts leading to ICES advice.**

		COD-CS	HAD-CS	WHG-CS
2017	Total Catches*			
	Baseline	3323	14996	20898
	ICES	3323	14996	20788
	% difference	0.0%	0.0%	0.5%
2018	Total Catches**			
	Baseline	3429	8393	19548
	ICES	3099	8393	19548
	% difference	10.6%	0.0%	0.0%

\*COD-CS landings only

\*\*COD-CS baseline includes a 10.6% inflation for discards included in the single species forecast

**Table 3.5.2.2.a Celtic Sea. Results of Final Fcube runs.**

	YEAR	SCENARIOS	COD-CS	HAD-CS	WHG-CS
landings	2017	baseline	3323	14996	20898
Fbar	2017	baseline	0.44	0.58	0.43
	2018	baseline	0.3	0.4	0.52
FmultVsF16	2017	baseline	1	0.85	1
	2017	sq_E	1	1	1
	2018	baseline	0.68	0.6	1.22
	2018	cod-cs	0.68	0.68	0.69
	2018	had-cs	0.67	0.6	0.58
	2018	max	1.14	1.15	1.22
	2018	min	0.59	0.57	0.56
	2018	sq_E	1	1	1
	2018	val	0.88	0.89	0.97
	2018	whg-cs	1.13	1.14	1.22
landings	2017	sq_E	3323	16899	20898
	2018	baseline	3429	8393	19548
	2018	cod-cs	3429	8701	12097
	2018	had-cs	3412	7806	10432
	2018	max	5291	13193	19595
	2018	min	3036	7455	10064
	2018	sq_E	4760	11864	16640
	2018	val	4295	10853	16174
	2018	whg-cs	5252	13112	19548
Ld_MgtPlan	2018	sq_E	3076	7806	19548
catches	2017	sq_E	3323	16899	20898
	2018	baseline	3429	8393	19548
	2018	cod-cs	3429	8701	12097
	2018	had-cs	3412	7806	10432
	2018	max	5291	13193	19595
	2018	min	3036	7455	10064
	2018	sq_E	4760	11864	16640
	2018	val	4295	10853	16174
	2018	whg-cs	5252	13112	19548
ssb	2017	baseline	7140	32936	58288
	2018	baseline	8755	20257	48763
	2018	sq_E	8755	18497	48763
	2019	cod-cs	12009	23031	52949
	2019	had-cs	12027	23880	54386
	2019	max	10063	18803	46544
	2019	min	12423	24213	54705
	2019	sq_E	10615	20047	49055
	2019	val	11100	20998	49452
	2019	whg-cs	10104	18878	46584
ssb_MgtPlan	2018	sq_E	8755	18497	48763

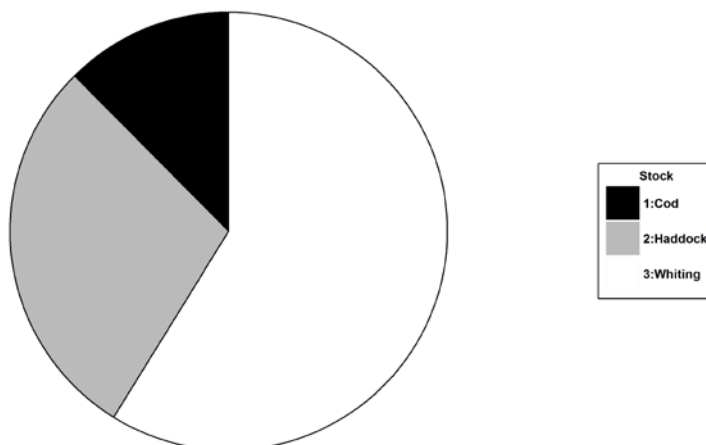
**Table 3.5.2.2.b Celtic Sea. Catches under the mixed fisheries scenarios relative to the single stock advice.**

Stock	Single-stock catches	Catches per mixed-fisheries scenario 2017 relative to the single stock advice						
	advice 2017*	"Max"	"Min"	"Cod-cs"	"Had-cs"	"Whg-cs"	"Sq_E"	"Val"
Cod 7.e-k	3.454	1.532	0.879	0.993	0.988	1.521	1.378	1.243
Haddock 7.bc, 7.e-k	8.393	1.572	0.888	1.037	0.930	1.562	1.414	1.293
Whiting 7.bc, 7.e-k	19.548	1.002	0.515	0.619	0.534	1.000	0.851	0.827

\*Weights in thousand tonnes.

Advised catches no more than the indicated value.

### Total Landings by Stock



**Figure 3.4.1.a Celtic Sea. Distribution of landings of those stocks included in the mixed fisheries projections.**



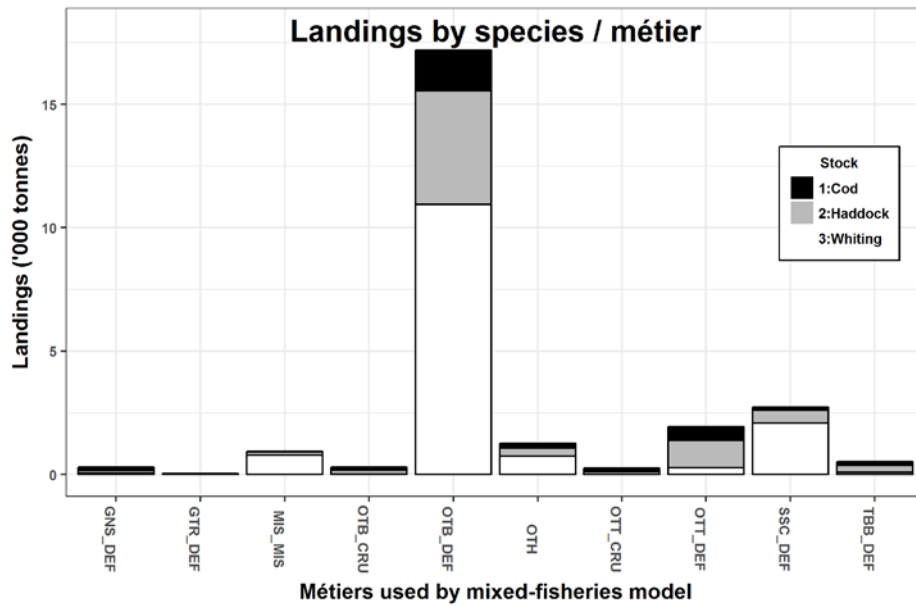


Figure 3.4.1.b Celtic Sea. Landings distribution of species by métier with landings consisting of  $\geq 1\%$  of any of the stocks 1–10 in 2016 Note: The “other” (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and métier with landings  $< 1\%$  of any of the stocks 1–10 in 2015. 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 6 and 6.a respectively.

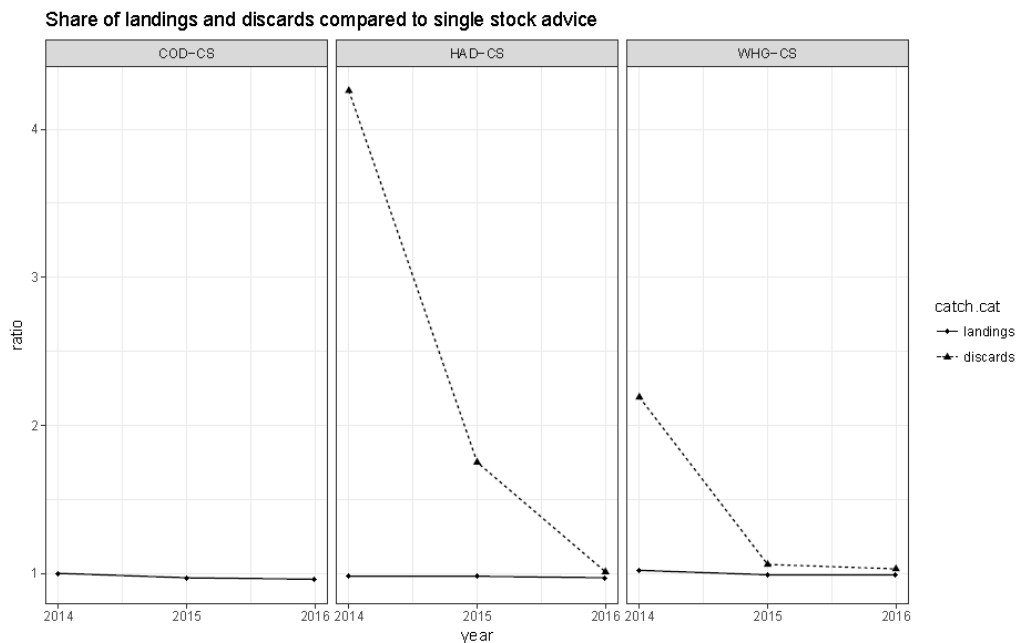


Figure 3.4.2 Celtic Sea. Ratio between the sum of landings (blue, l) and discards (red, d) across fleets used in the MIXFISH analysis and the landings and discards estimated by the WGCSE stock assessments.

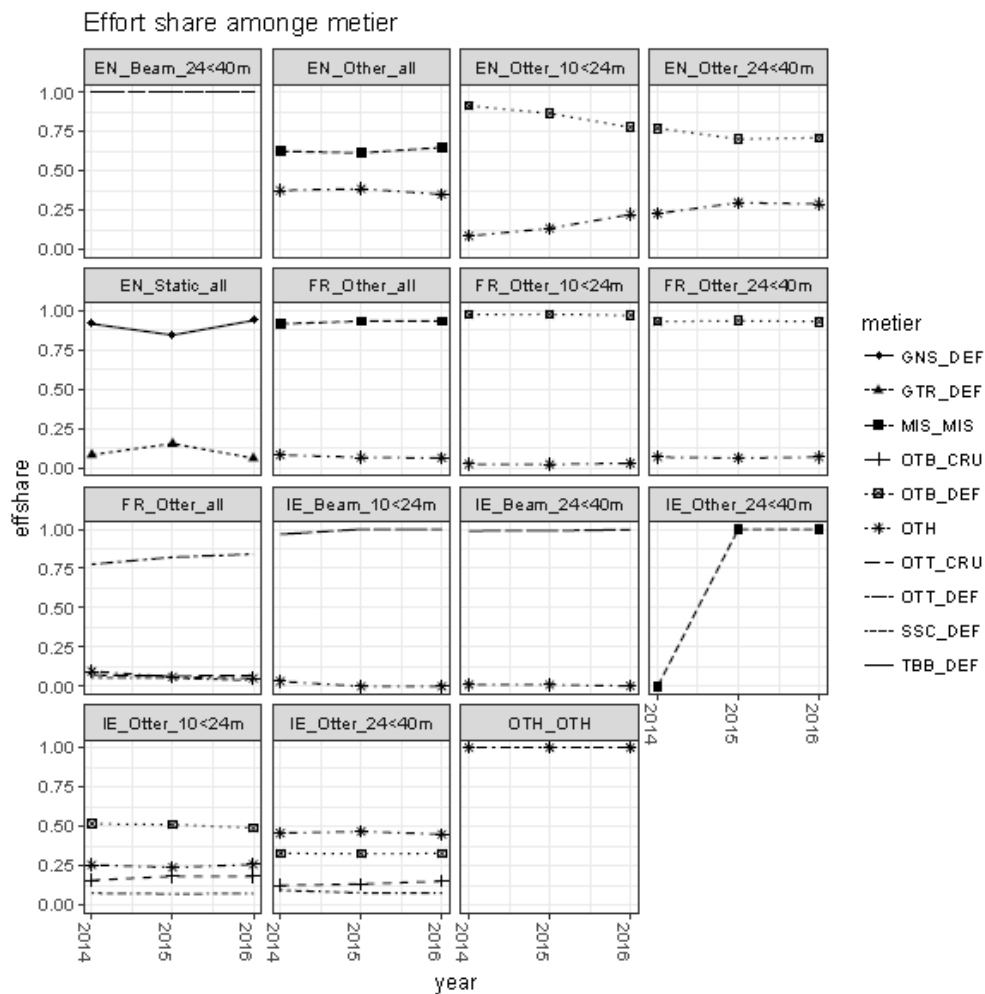


Figure 3.4.3.a Effort share (in proportion) by métier for each fleet.

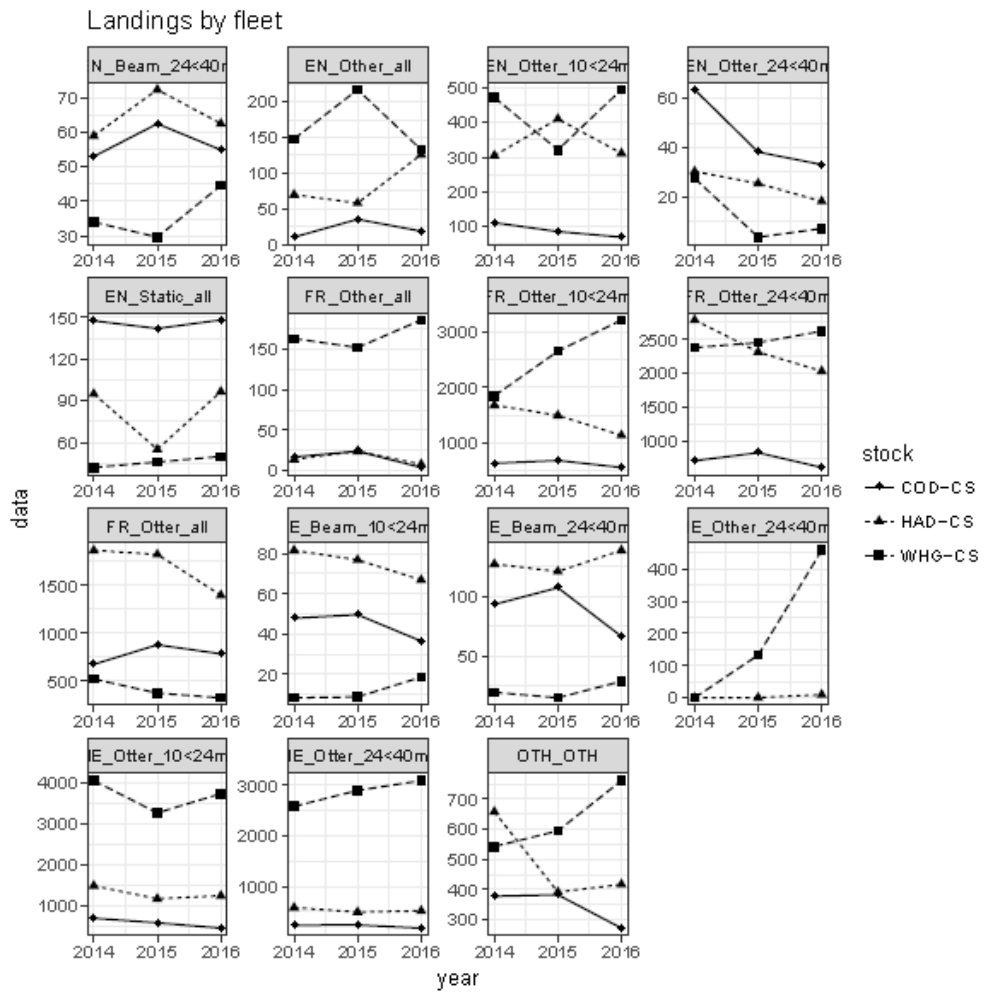


Figure 3.4.3.b Landings by fleet, stock and year. Note: different scales on the y-axis.

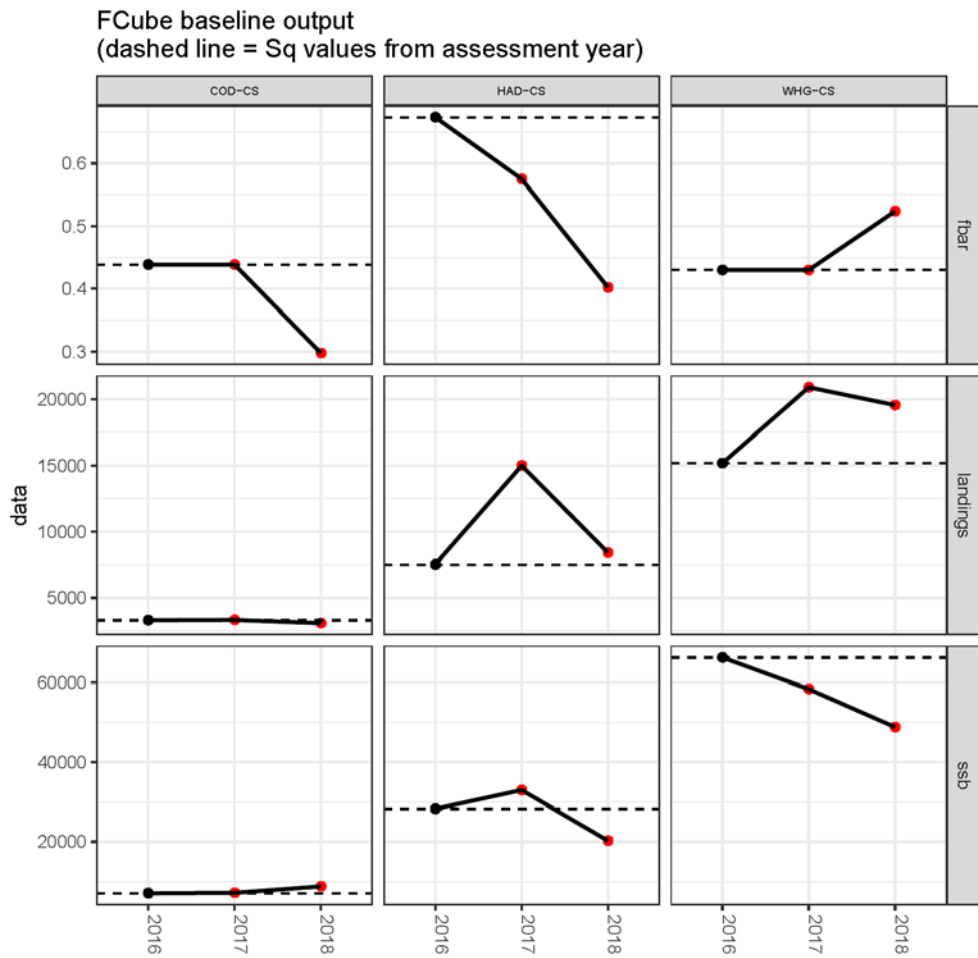


Figure 3.5.2.1.a Change in fishing mortality (Fbar), landings (tonnes) and SSB (tonnes) assumed in the intermediate year (2017) and required for the TAC year (2018) under the single stock forecast assumptions consistent with the MSY approach.

Reproduce the advice diagnostic plot Analytical stocks.  
 Values are percentage deviation of Fcube baseline run from single species outpu

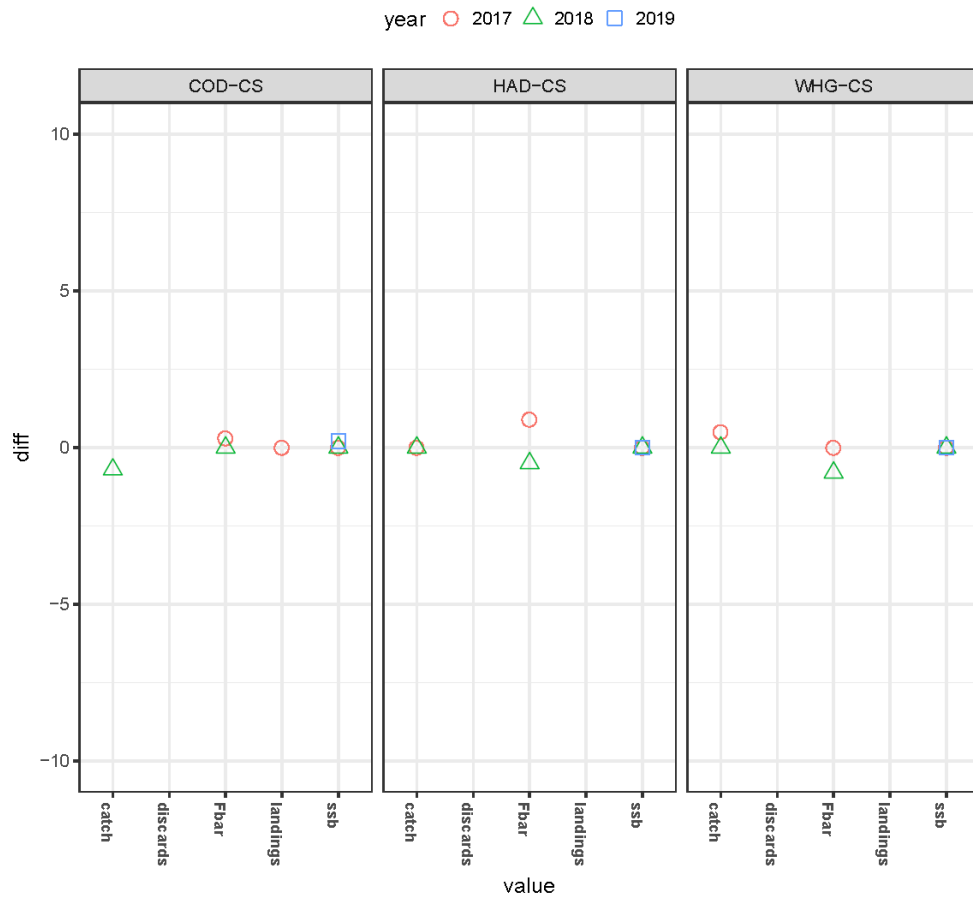


Figure 3.5.2.1.b Celtic Sea. Difference between Fcube baseline run and Single Species advice for finfish stocks, showing Fbar (2016–2017), catch, discards and landings (2016–2017) and SSB (2017–2018).

**Predicted catch for 2017, per stock and scenario**

overshoot (hatched) and undershoot (below zero)

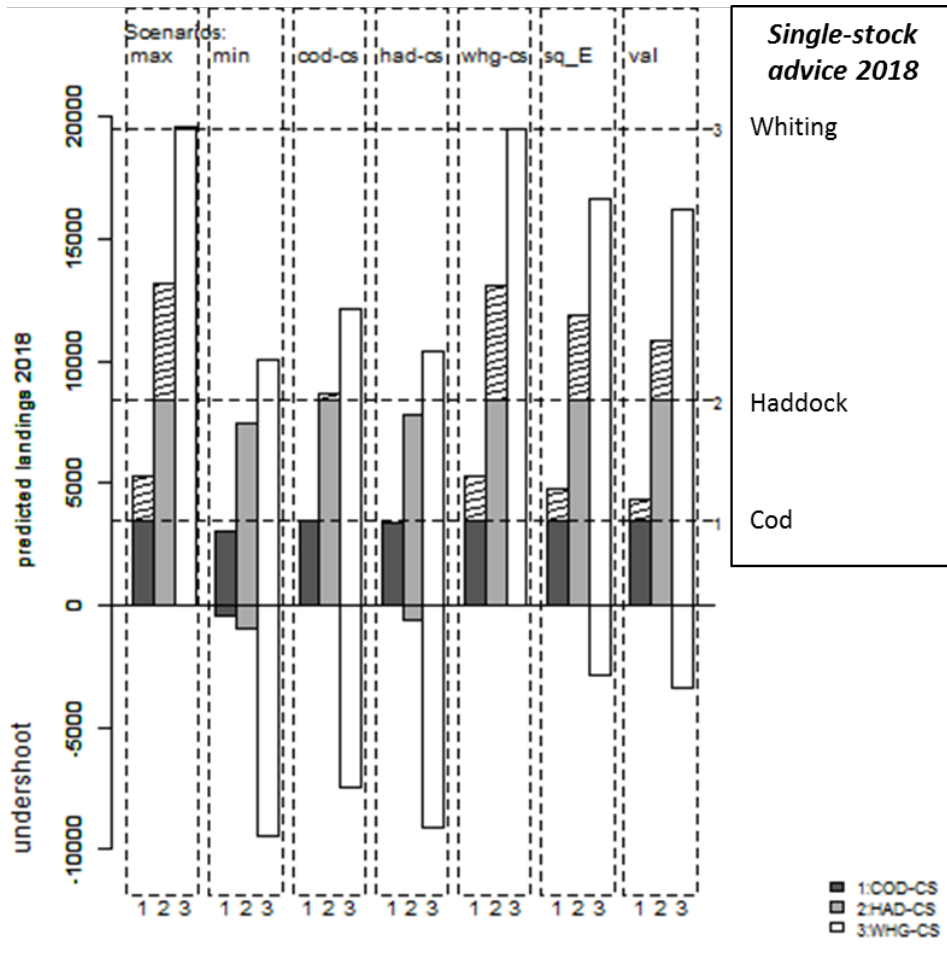


Figure 3.5.2.2.a Celtic Sea. TAC year results (2017). Fcube estimates of potential landings by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single stock advice. Bars below the value of zero show the scale of undershoot (compared to the single species TAC) in cases where landings are predicted to be lower when applying the scenario.

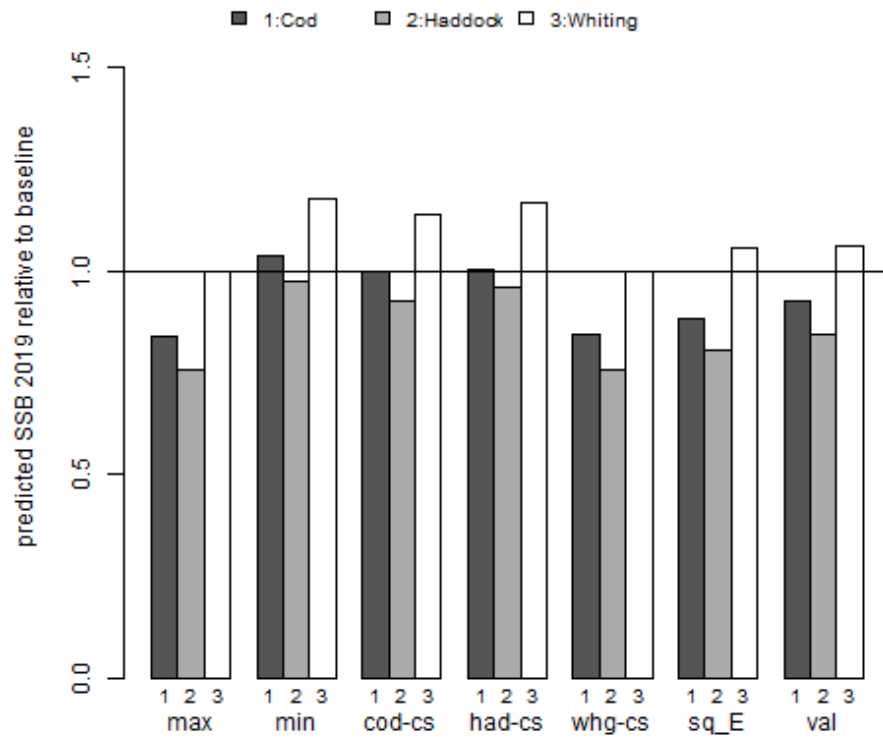


Figure 3.5.2.2.b Celtic Sea. Estimates of potential SSB at the start of 2018 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single stock advice (at the start of 2018).

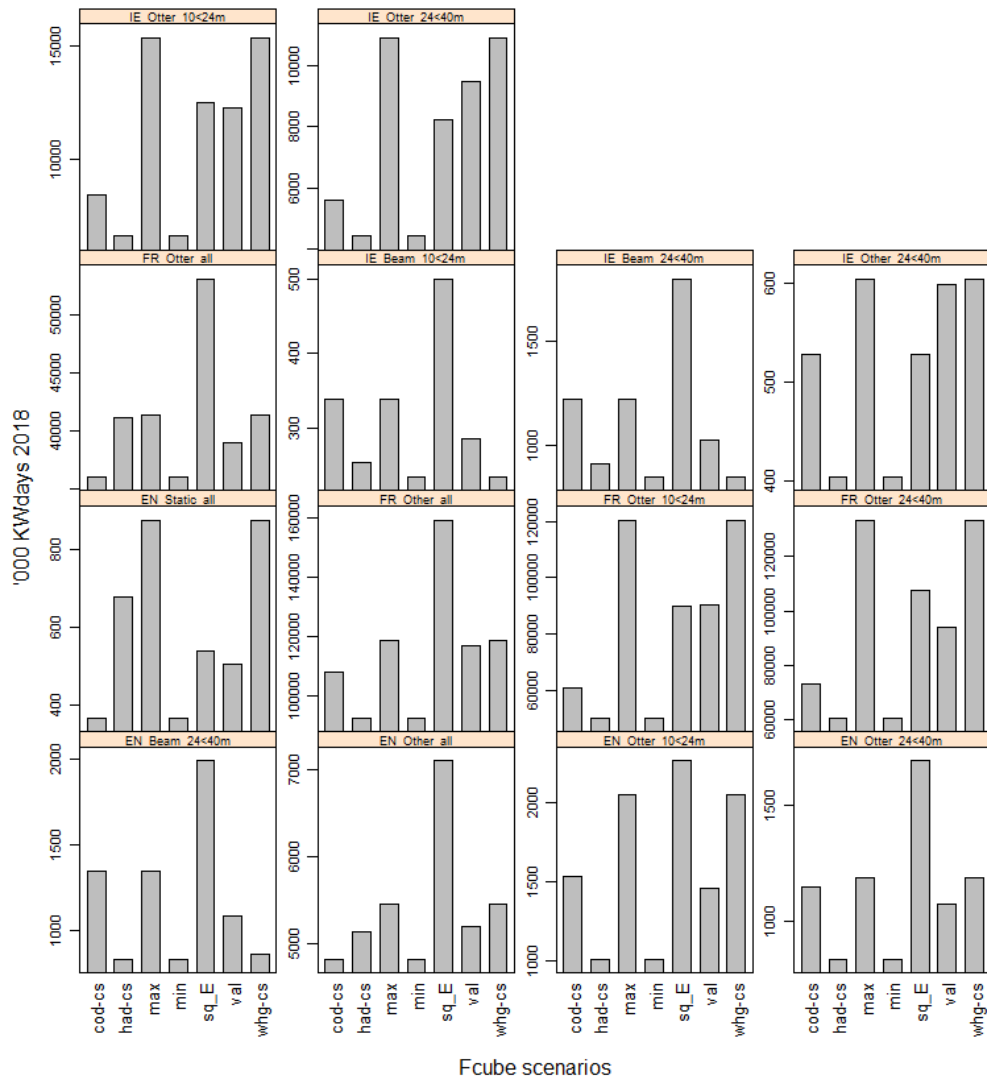


Figure 3.5.2.2.c Celtic Sea. TAC year results (2017). Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2018 (baseline run).



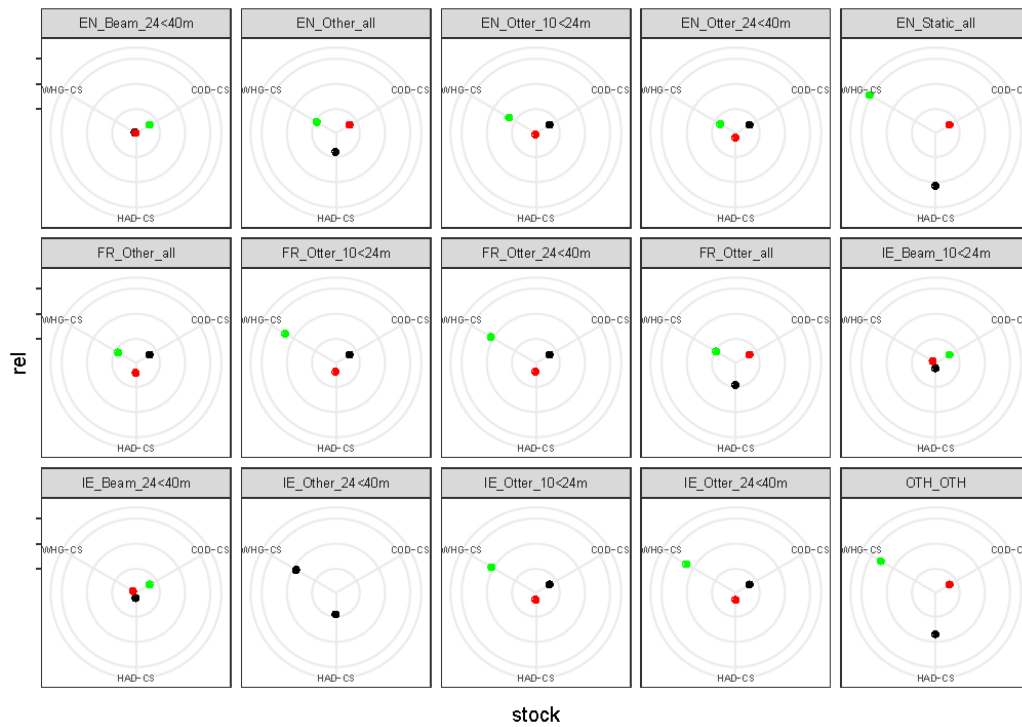


Figure 3.5.2.2.d Mixed-fisheries advice in the Celtic Sea. Relative fishing effort required to catch each quota by fleet. Each wedge represents the fishing effort required to catch one quota, with the fishing effort to reach the least limiting quota equal to one (outer edge of ring) coloured in green. The most limiting stock is coloured in red. The width of the wedge is proportional to the landings of the stock by the fleet in 2016.

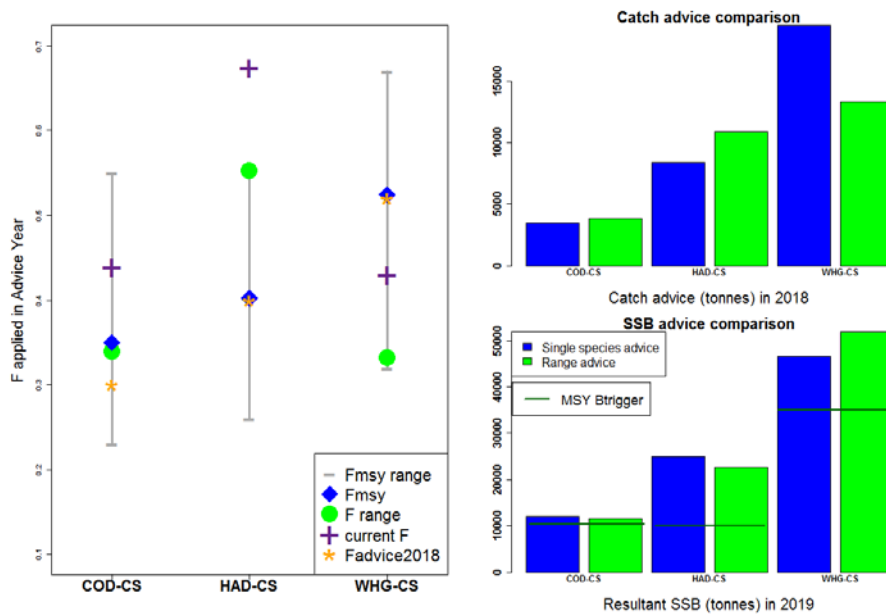


Figure 5.3.2.2.e Range scenario advice for divisions 7.b–c and 7.e–k. Left: the fishing mortality rates for each stock which reduce the mismatch between opportunities for the three stocks (green point), along with the current fishing mortality (purple cross), the fishing mortality corresponding to the single stock advice (yellow star) and the  $F_{MSY}$  (blue rotated square) and the  $F_{MSY}$  ranges (grey lines). Right: Comparison of the outcomes in terms of total catches in 2018 (top) and SSB in 2019 (Bottom) between the  $F_{MSY}$ -based single stock advice and the  $F$ -range based forecast.

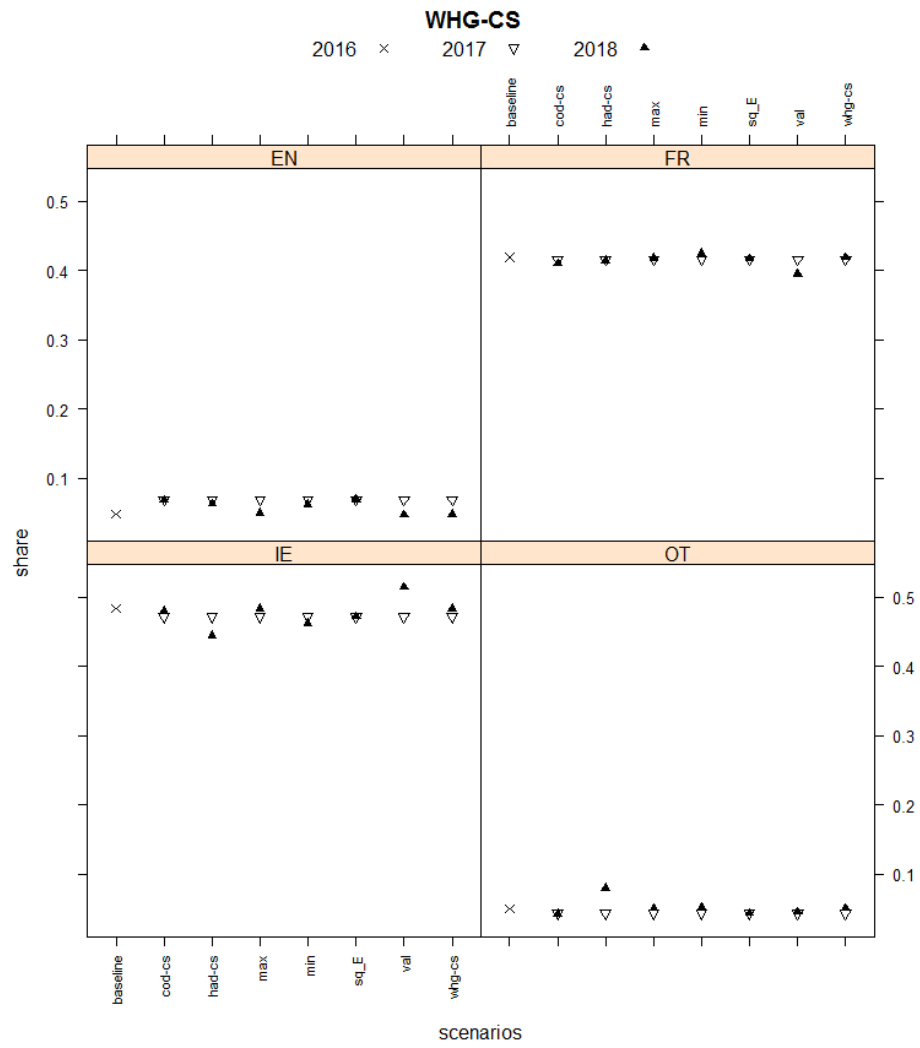


Figure 3.5.2.2.2 Test for relative stability. Changes of relative share of species' landings by country in 2016 and compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

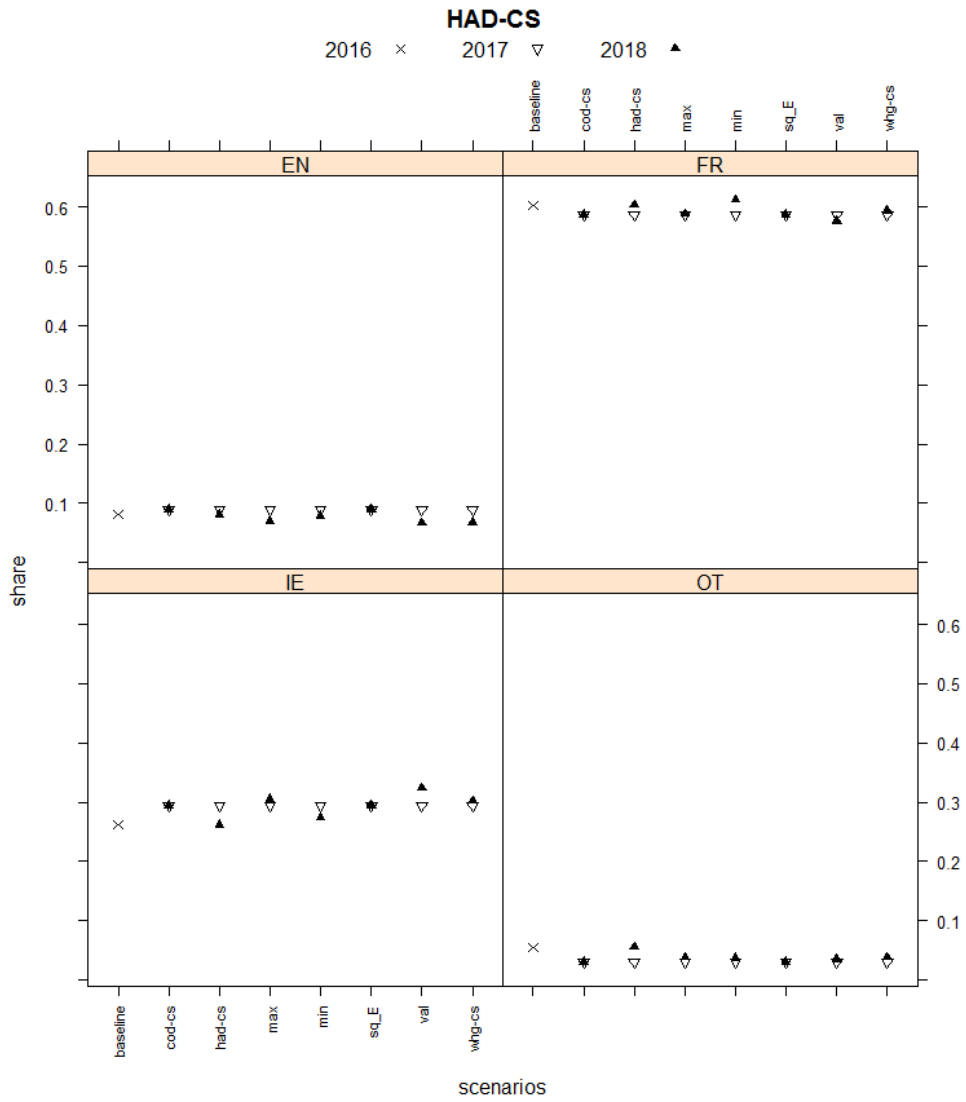


Figure 3.5.2.2.2 (cont) Test for relative stability. Changes of relative share of species' landings by country in 2016 and compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

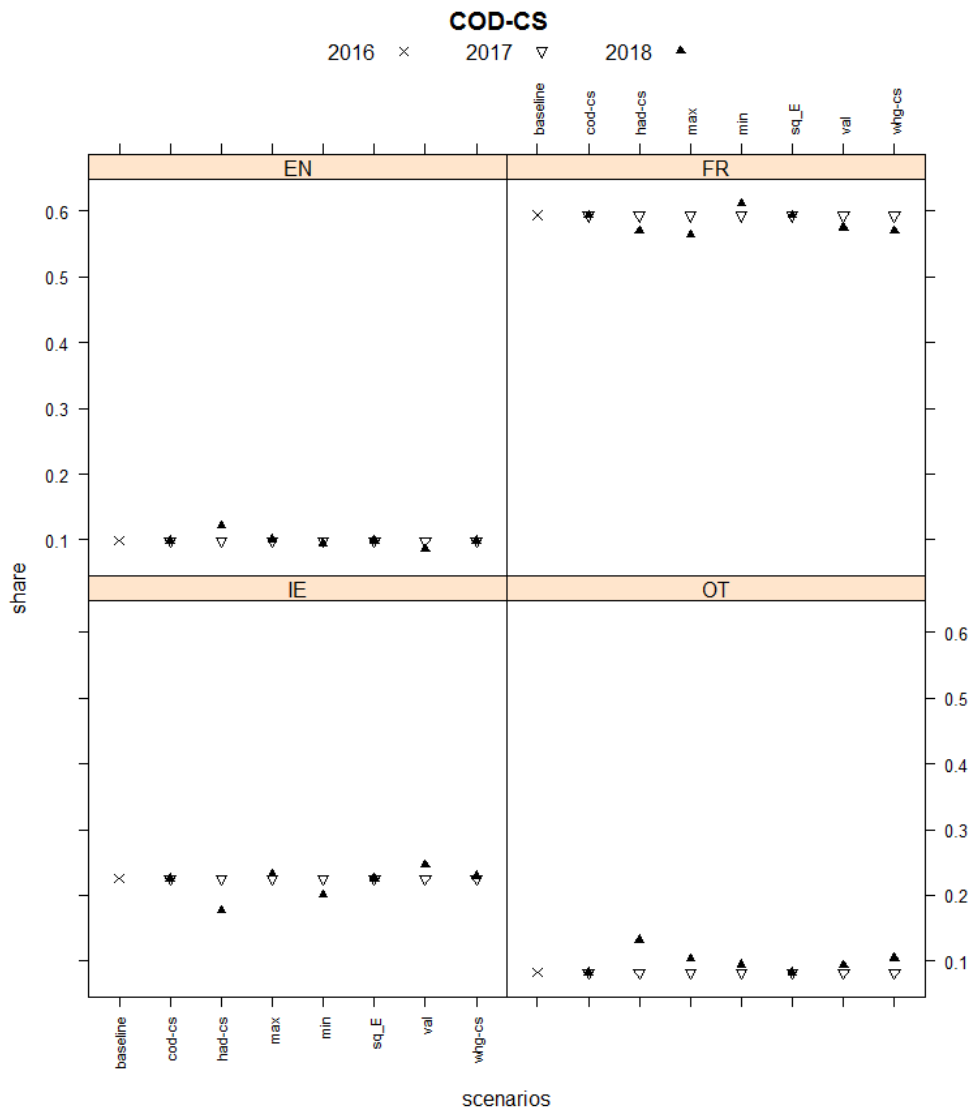


Figure 3.5.2.2.2 (cont). Test for relative stability. Changes of relative share of species' landings by country in 2016 and 2017 compared to the 2015 share, for the 'baseline' and 6 Fcube scenarios.

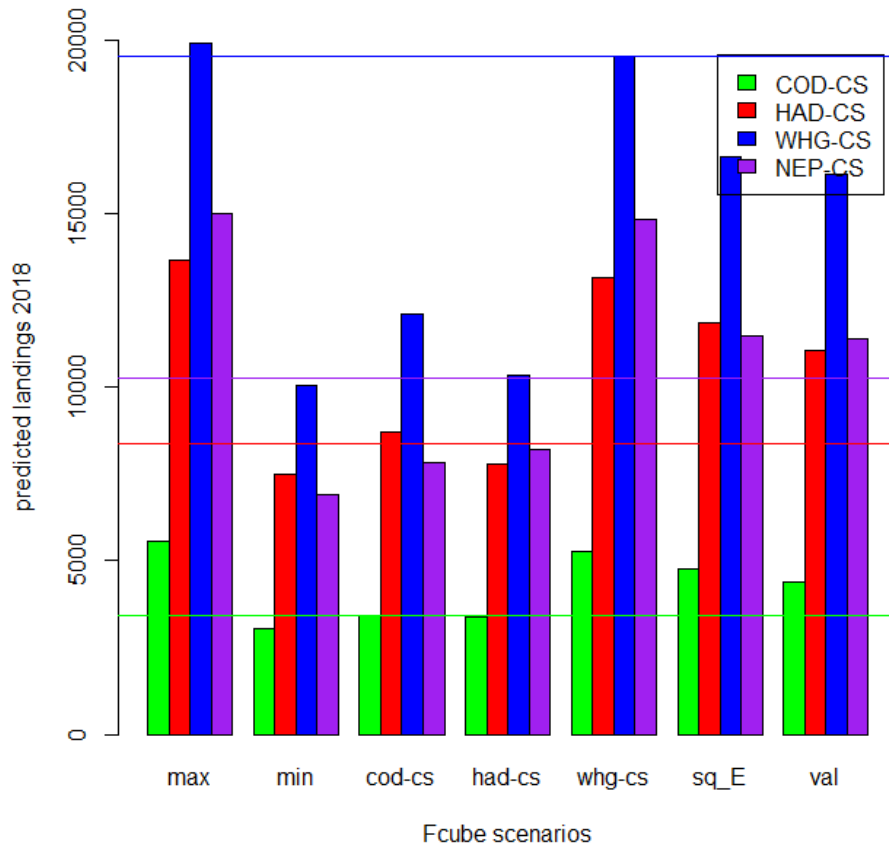


Figure 3.6 Celtic Sea mixed fisheries scenarios for the TAC year (2018) incorporating *Nephrops* stocks from ICES areas 7. b-k.

## 4 Iberian waters

### 4.1 Background

#### 4.1.1 Effort limitations

For vessels registered in EU member states, effort restrictions in terms of days at sea were introduced in Annex IVb of Council Regulation 27/2005 and amended by Council on an annual basis (Annex IIB since then). The objective of this management plan is the recovery of hake and *Nephrops* of ICES Divisions 8.c and 9.a, and it is applied in both divisions with the exception of Gulf of Cadiz. The baselines assigned in 2017 (EU Regulation 2017/127) were based on track record per vessel on years 2013 and 2014.

#### 4.1.2 Stock-based management plans

Hake is the only stock considered here as part of the demersal mixed fisheries of the Iberian waters, which is subject to multi-annual management plans (Council Regulation (EC) N° 2166/2005). This plan seeks to rebuild the stock to safe biological limits, set as a spawning-stock biomass above 35 000 tonnes by 2016, and to reduce fishing mortality to 0.27. The main elements of the plan are a 10% annual reduction in F and a 15% constraint on TAC change between years. Since the enforcement of the plan, the stock historical perception has changed. The SSB of the recovery plan is therefore no longer valid and the stock has returned to a healthy state (WGBIE; ICES, 2017).

### 4.2 Fcube

#### 4.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.*, 2007; [www.flr-project.org](http://www.flr-project.org); FLCORE 2.5.0, FLAssess 2.5.0, Flash 2.5.0) running with R2.15.1 (R Development Core Team, 2011). All forecasts were projected using the same `fwd()` function in the Flash Package. The Fcube method is developed as a stand-alone script using FLR objects as inputs and outputs.

Software used in the single species assessments and forecasts was as outlined in the text table below.

Species	Assessment	Forecast
HAKE 8.c-9.a	GADGET	GADGET (script: predict.st.sh)
FOUR-SPOT MEGRIM 8.c-9.a	XSA	MFDP
MEGRIM 8.c-9.a	XSA	MFDP
WHITE ANGLERFISH 8.c-9.a	SS3	SS3 (ad hoc R code)

#### 4.2.2 Scenarios

The basis of the model is to estimate the potential future levels of effort by a fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

In 2017, single stock ICES advice was given according to MSY approach. Therefore, the same basis was retained in the current mixed-fisheries framework, in which the following eight scenarios are considered in the advice:

- 3) **max**: The underlying assumption was that fishing stops when all quota species are fully utilized with respect to the upper limit corresponding to single stock exploitation boundary.
- 4) **min**: The underlying assumption was that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary.
- 5) **hke**: The underlying assumption was that all fleets set their effort at the level corresponding to their hake quota share, regardless of other stocks.
- 6) **ldb**: The underlying assumption was that all fleets set their effort at the level corresponding to their four-spot megrim quota share, regardless of other stocks.
- 7) **meg**: The underlying assumption was that all fleets set their effort at the level corresponding to their megrim quota share, regardless of other stocks.
- 8) **mon**: The underlying assumption was that all fleets set their effort at the level corresponding to their white anglerfish quota share, regardless of other stocks.
- 9) **sq\_E**: The effort was set as equal to the effort in the most recently recorded year for which landings and discard data were available.
- 10) **val**: The effort by fleet is equal to the average of the efforts required to catch the quota of each of the stocks, weighted by the historical catch value of that stock.

### 4.3 Stock input data and recent trends

#### 4.3.1 Stocks

##### 4.3.1.1 Data

The assessment data for the different stocks were taken from WGBIE (ICES, 2017). Two of the WGBIE stocks considered here are being assessed using stochastic assessments: GADGET model for southern hake and SS3 for southern white anglerfish. These also make use of stochastic projections, which cannot easily be fully replicated in the deterministic Fcube software. However, Fcube projections are routinely compared to the median projections of the single species stochastic forecasts on which single stock advice is based. The results show variation mainly for hake, as such WGMIXFISH consider the difference may impact significantly on the mixed fisheries advice.

The final dataset extracted from InterCatch for use by WGBIE includes discards estimates for all stocks and some métiers, and they are included in the assessment of hake and both megrims. InterCatch files also provided non-reported landings besides the official landings. The fleet files specifically required by the WGMIXFISH, needed to split landings by fleet segment and metier, were provided by Spain and Portugal with official landings and economic value. France only provided landings. Discards and non-reported landings were added during the meeting from the respective InterCatch files.

##### 4.3.1.2 Trends and Advice

**This advice is drafted by the WGBIE-2017 before considerations by ACOM.**

Recent trends in SSB, F and recruitment are described on a stock-by-stock basis in ICES (2017), and latest advice by stock is available on the ICES website. In order to give a

global overview of all Iberian demersal stocks, this information is summarized below. It should be noted that although there is only one advice, additional management considerations are also listed in the single species advice. Table 4.3.1.2 lists the final advised TACs for 2018 and expected SSBs in 2019.

**Table 4.3.1.2.1 Analytical stocks**

SPECIES	AREA	STOCK STATUS					SUMMARY	ADVICE 2016
Hake	Divisions 8.c and 9.a	Fishing pressure					The spawning-stock biomass (SSB) has increased since 1998 and is above MSY $B_{trigger}$ in 2016. The fishing mortality (F) is above $F_{MSY}$ . Recruitment (R) has since 2010 been close to the historical mean.	ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 8 561 tonnes. Since this stock is only partially under the EU landing obligation, ICES is not in a position to advise on landings corresponding to the advised catch.
			2014	2015	2016			
		$F_{MSY}$	✗	✗	✗	Above		
		$F_{pa}, F_{lim}$	✓	✓	✓	Harvested sustainably		
		$F_{MGT}$	-	-	-	Not applicable		
		Stock size						
			2015	2016	2017			
		MSY $B_{trigger}$	✓	✓	✓	Above trigger		
		$B_{pa}, B_{lim}$	✓	✓	✓	Full reproductive capacity		
		SSB <sub>MGT</sub>	-	-	-	Not applicable		
Four-spot megrim	Divisions 8.c and 9.a	Fishing pressure					The spawning-stock biomass (SSB) decreased from the late 1980s to a minimum in 2001, but since then SSB has increased to the current maximum value and is above MSY $B_{trigger}$ . Fishing mortality (F) has decreased in the last year and has always been above $F_{MSY}$ . Record-high recruitment is estimated in 2012 and 2014.	ICES advises on the basis of the MSY approach that catches in 2018 should be no more than 1399 tonnes. If discard rates do not change from the average of the last five years (2012–2016), this implies landings of no more than 1139 tonnes.
			2014	2015	2016			
		$F_{MSY}$	✗	✗	✗	Above		
		$F_{pa}, F_{lim}$	✓	✓	✓	Harvested sustainably		
		$F_{MGT}$	-	-	-	Not applicable		
		Stock size						
			2015	2016	2017			
		MSY $B_{trigger}$	✓	✓	✓	Above trigger		
		$B_{pa}, B_{lim}$	✓	✓	✓	Full reproductive capacity		
		SSB <sub>MGT</sub>	-	-	-	Not applicable		
Megrim	Divisions 8.c and 9.a	Fishing pressure					The spawning-stock biomass (SSB) has increased from the minimum observed in 2009 and is now above MSY $B_{trigger}$ . Fishing mortality (F) declined continuously until 2010, but has increased since then and is now above $F_{MSY}$ . After a period of low recruitment (R), it has increased in the last years.	ICES advises on the basis of the MSY approach that catches in 2018 should be no more than 292 tonnes. If discard rates do not change from the average of the last five years (2012–2016), this implies landings of no more than 276 tonnes.
			2014	2015	2016			
		$F_{MSY}$	✗	✗	✗	Above		
		$F_{pa}, F_{lim}$	✓	✓	✓	Harvested sustainably		
		$F_{MGT}$	-	-	-	Not applicable		
		Stock size						
			2015	2016	2017			
		MSY $B_{trigger}$	✓	✓	✓	Above trigger		
		$B_{pa}, B_{lim}$	✓	✓	✓	Full reproductive capacity		
		SSB <sub>MGT</sub>	-	-	-	Not applicable		



SPECIES	AREA	STOCK STATUS				SUMMARY	ADVICE 2016	
White anglerfish	Divisions 8.c and 9.a	Fishing pressure				<p>The spawning-stock biomass (SSB) has been increasing since 1994 and has been above MSY <math>B_{trigger}</math> since 2004. Fishing mortality (F) has been below <math>F_{MSY}</math> since 2008. Recruitment (R) has been low in recent years with no evidence of strong year classes since 2001.</p>	<p>ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 2197 tonnes.</p>	
			2014	2015	2016			
		$F_{MSY}$	✓	✓	✓			Appropriate
		$F_{pa}, F_{lim}$	✓	✓	✓			Harvested sustainably
		$F_{MGT}$	-	-	-			Not applicable
		Stock size						
			2015	2016	2017			
		$MSY B_{trigger}$	✓	✓	✓			Above trigger
		$B_{pa}, B_{lim}$	✓	✓	✓			Full reproductive capacity
		$SSB_{MGT}$	-	-	-			Not applicable

Table 4.3.1.2.2 Analytical stocks (not included)

SPECIES	AREA	STOCK STATUS				SUMMARY	ADVICE 2016	
Black anglerfish	Divisions 8.c and 9.a	Fishing pressure				<p>The stock biomass (B) has been increasing since 2000 and is estimated to be above MSY <math>B_{trigger}</math> over most of the time-series. Fishing mortality (F) has decreased since 1999 and is estimated to have been below <math>F_{MSY}</math> since 2008.</p>	<p>ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 2349 tonnes.</p>	
			2014	2015	2016			
		$F_{MSY}$	✓	✓	✓			Appropriate
		$F_{pa}, F_{lim}$	✓	✓	✓			Harvested sustainably
		$F_{MGT}$	-	-	-			Not applicable
		Stock size						
			2015	2016	2017			
		$MSY B_{trigger}$	✓	✓	✓			Above trigger
		$B_{pa}, B_{lim}$	✓	✓	✓			Full reproductive capacity
		$SSB_{MGT}$	-	-	-			Not applicable

Table 4.3.1.2.3 Nephrops stocks

SPECIES	AREA	STOCK STATUS				SUMMARY	ADVICE 2016	
Nephrops	Division 8.c FU25	Fishing pressure				All information indicates that the stock is at very low abundance level. Landings and lpue have declined continuously. The update of recent data indicates a slight increase in landings and abundance index but remain extremely low.	ICES advises on the basis of the precautionary considerations that there should be no directed fishery and that bycatch should be <b>minimized</b> in both 2017 and 2018. To protect the stock in this functional unit, ICES advises that the management area should be consistent with the assessment area.	
			2013	2014	2015			
		$F_{MSY}$	-	✓	-			Undefined
		$F_{pa}F_{lim}$	-	✓	-			Undefined
		$F_{MGT}$	-	-	-			Not applicable
		Stock size						
			2013	2014	2015			
		$MSY$ $B_{trigger}$	✗	✗	✗			Below
		$B_{pa}B_{lim}$	✗	✗	✗			Below
		$SSB_{MGT}$	-	-	-			Not applicable
Nephrops	Division 9.a FU2627	Fishing pressure				All information indicates that the stock is at a very low abundance level. Landings and lpue have fluctuated along a marked downward trend and are currently very low. Mean sizes have shown an increasing trend over the time-series, which may reflect poor recruitment.	ICES advises that when the precautionary approach is applied, there should be no directed fishery and bycatch should be <b>minimized</b> in both 2017 and 2018. To protect the stock in these functional units, ICES advises that management should be implemented at the functional unit level.	
			2013	2014	2015			
		$F_{MSY}$	-	✓	-			Undefined
		$F_{pa}F_{lim}$	-	✓	-			Undefined
		$F_{MGT}$	-	-	-			Not applicable
		Stock size						
			2013	2014	2015			
		$MSY$ $B_{trigger}$	✗	✗	✗			Below
		$B_{pa}B_{lim}$	✗	✗	✗			Below
		$SSB_{MGT}$	-	-	-			Not applicable
Nephrops	Division 9.a FU2829	Fishing pressure				Standardized commercial CPUE (used as the stock size indicator) has increased since 2011 and the mean size of individuals has been relatively stable over time.	ICES advises that when the precautionary approach is applied, catches in 2018 should be no more than 281 tonnes. All catches are assumed to be landed.	
			2013	2014	2015			
		$F_{MSY}$	✓	✓	✓			Appropriate
		$F_{pa}F_{lim}$	?	?	?			Undefined
		$F_{MGT}$	-	-	-			Not applicable
		Stock size						
			2013	2014	2015			
		$MSY$ $B_{trigger}$	?	?	?			Undefined
		$B_{pa}B_{lim}$	?	?	?			Undefined
		$SSB_{MGT}$	-	-	-			Not applicable

Nephrops	Division 9.a FU30	Fishing pressure				
			2013	2014	2015	
		$F_{MSY}$	-	✓	-	Undefined
		$F_{pa}F_{lim}$	-	✓	-	Undefined
		$F_{MGT}$	-	-	-	Not applicable
		Stock size				
			2013	2014	2015	
		$MSY$ $B_{trigger}$	-	?	-	Unknown
		$B_{pa}B_{lim}$	-	?	-	Unknown
		$SSB_{MGT}$	-	-	-	Not applicable
<p>Over the time series the abundance index have declined up to 2010 but it increased in the 2011-2013 period. The update of the index indicates that the abundance of the stock has decreased in recent years. The reduction of the size indicator (cpue) in the last two years (2014-2015) was greater than 20%. The effort between 2013 and 2015 remained stable and was 80% lower than observed in the 2008-2012 period due to the penalty applied in the period for exceeding the quota in 2012.</p>						
<p>ICES advises on the basis of the precautionary approach that catches should be no more than 76 tonnes in each of the years 2017 and 2018. All catches are assumed to be landed. To protect the stock in this functional unit, ICES advises that management should be implemented at the functional unit level.</p>						
Nephrops	Division 8.c FU31	Fishing pressure				
			2013	2014	2015	
		$F_{MSY}$	-	✓	-	Undefined
		$F_{pa}F_{lim}$	-	✓	-	Undefined
		$F_{MGT}$	-	-	-	Not applicable
		Stock size				
			2013	2014	2015	
		$MSY$ $B_{trigger}$	✗	✗	✗	Below
		$B_{pa}B_{lim}$	✗	✗	✗	Below
		$SSB_{MGT}$	-	-	-	Not applicable
<p>All information indicates that the stock is at a very low abundance level. Landings and lpue have declined continuously and are currently extremely low.</p>						
<p>ICES advises on the basis of the precautionary considerations, that there should be no directed fishery and bycatch should be <b>minimized</b> in both 2017 and 2018. To protect the stock in this functional unit, ICES advises that the management area should be consistent with the assessment area.</p>						

**Table 4.3.1.2.4 Ancillary stocks**

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Seabass	Divisions 8.c and 9.a	Not available yet	Not available yet	Not available yet
Plaice	Subarea 8 and Division 9.a	Not available yet	Not available yet	Not available yet
Pollack	Subarea 8 and Division 9.a	Not available yet	Not available yet	Not available yet
Sole	Divisions 8.c and 9.a	Not available yet	Not available yet	Not available yet
Whiting	Subarea 8 and Division 9.a	Not available yet	Not available yet	Not available yet

## 4.4 Fleets and métiers

### 4.4.1 Catch and effort Data

Métier-based landings and effort files requested by the WGMIXFISH data call were provided by the three countries with fleets in Atlantic Iberian waters, *i.e.* Spain, Portugal and France. InterCatch datafiles are also needed to compile discards and non-reported landings which are not provided in the MIXFISH datacall. From the time series required (2009–2016), only the last three years (2014–2016) were used to carry out a comparison of effort and catches by country, fleet and métier.

### 4.4.2 Definitions of fleets and métiers

The fleet and métier disaggregation available was the current DCF structure for the Spanish, Portuguese and French fleets. As the French data only present landings of hake, which were not considered in the hake assessment, they were not included in the mixed-fisheries analysis for consistency. The final data provided to the WG contained 14 métiers (Table 4.4.2.a). Regarding fleet segments, size vessels categories were only required for trawl gear: < 10m, 10 < 24 m, and 24 < 40 m.

Total catches (in weight) obtained by multiplying the catch-at-age in numbers by the average weight at age used as input in the WGMIXFISH analysis are compared with the total catches (in weight) used by WGBIE in the single species assessments (Table 4.4.2.b). The largest discrepancies are observed for hake, surely due to mathematical differences between the model used for the single stock assessment in WGBIE and the analytical approach used here.

The original 14 métiers were regrouped for the mixed-fisheries analysis according to the ecological group of target species and the technical characteristics of the fishing gear, obtaining 10 métiers (Figure 4.4.2). Hake provides the highest catches of all métiers except for DEF\_>=100\_0\_0, which corresponds with the Spanish gillnet targeting white anglerfish (“*rasco*”). Megrimms are mainly caught by the bottom otter trawl métiers, identified here as DEF\_>=55\_0\_0 and DEF\_>65\_0\_0.

With respect to the fleet segments used in the mixed-fisheries analysis, these were defined combining the country, the fishing gear group (first three letters of the métier acronym) and the vessel size (LOA: Length Overall).

### 4.4.3 Trends

Analyses of trends by fleet were carried out on 2014–2016 data. A number of overview graphs (using the Lattice package in R) were produced to aid quality checking of the data once compiled into the final fleets object for catches, effort and catchability. In order not to extend the report with repetitive graphics, only the catchability plots by stock, fleet and métier for Spain (Figure 2.4.3.a) and Portugal (Figure 2.4.3.b) are included in this report. Spanish catchabilities do not show particular trends, except a decrease for megrim and four-spot megrim in bottom otter trawl in 2016. On the other hand, the Portuguese catchabilities show a decrease for hake in artisanal métiers, and a decrease in catchability of both megrims and white anglerfish in the bottom otter trawl métier targeting demersal fish.

## 4.5 Mixed fisheries forecasts

Discrepancies were found between the Fcube baseline runs and the single stock forecasts in hake and white anglerfish similar to those obtained last year (ICES, 2016).

These discrepancies are attributed to methodological differences between the length-based assessment models used by WGBIE and the age-based forecast reproduced by WGMIXFISH. As expected, the Fcube baseline runs reproduced the megrim and four-spot megrim single stock forecasts, which are assessed by applying the XSA model.

#### 4.5.1 Description of scenarios

##### 4.5.1.1 Baseline Runs

The objectives of the single species stock baseline runs were to:

- reproduce as closely as possible the single species advice produced by ACOM, and
- act as the reference scenario for subsequent mixed fisheries analyses.

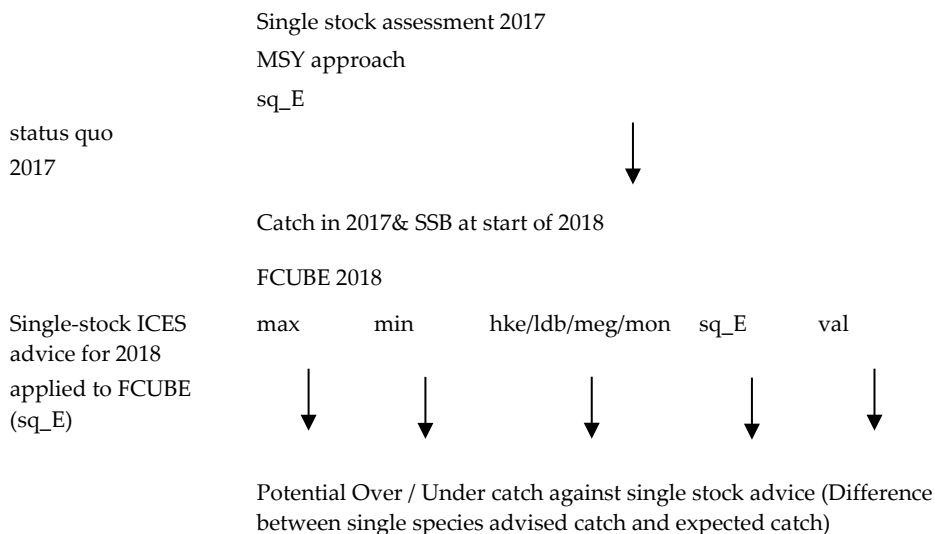
The various single stock forecasts presented by WGBIE are performed using different software and setups (see 4.2.1 above). However, for the purpose of the mixed-fisheries analyses, it is necessary to gather all forecasts into a single unified framework, which builds on the 'fwd()' method in FLR (Flash R add-on package). The same forecast settings as in WGBIE are used for each stock regarding weight-at-age, selectivity and recruitment, as well as assumptions on the F in the intermediate year and basis for advice (MSY approach).

##### 4.5.1.2 Mixed fisheries runs

The mixed fishery analysis used a *status quo* effort assumption for the intermediate year (2017), with the Fcube scenarios used for the TAC year (2018). The *status quo* effort assumption for the intermediate year is considered a plausible assumption because is in line with the standard single stock short-term forecasting approach.

As last year, the projections were run assuming a full and perfect implementation of a discard ban (*i.e.* all quota species caught must be landed, with no exemptions, *de minimis* or inter-species flexibilities).

In summary, the Fcube runs followed the scheme below:



## 4.5.2 Results of Fcube runs

### 4.5.2.1 Baseline run

The rationale behind the single species baseline runs is given in Section 4.3.1.2. The ICES single stock advice for these stocks in 2017 (ICES, 2017) is based on the maximum sustainable yield (MSY) approach. The issues and problems encountered in replicating the single species advice for each species are given below. The results from these baseline runs are compared with the results from the corresponding ICES runs in Tables 4.5.2.1.a and 4.5.2.1.b.

#### Hake

Discrepancies of 18% were obtained for hake. This stock is assessed by the GADGET model (Frøysa *et al.*, 2002; Begley and Howell, 2004), a stochastic assessment model which is difficult to simulate in a mixed-fisheries deterministic forecast. GADGET is a forward simulation model that can be structured in both age and length; therefore requiring direct modelling of growth within the model. In the case of southern stock of hake, the model is length based and F multipliers do not apply linearly. The southern stock of hake was assessed by applying XSA until 2009. However, evidences of substantial growth underestimation provided by tagging results, made evident the age overestimation by the internationally agreed age estimation method. In 2010, a benchmark (WKROUND) was undertaken in order to solve the consequences of this problem on the assessment, where a GADGET model was introduced (ICES, 2010).

#### Four-spot megrim

Straightforward, just minor differences found this year. This stock is assessed by applying the XSA model. In 2014, a benchmark (WKSOUTH) was undertaken in order to include discards on the assessment (ICES, 2014).

#### Megrim

Straightforward, no problems encountered. This stock is assessed by applying the XSA model. In 2014, a benchmark (WKSOUTH) was undertaken in order to include discards on the assessment (ICES, 2014).

### White anglerfish

Discrepancies of 5% were obtained for white anglerfish. The assessment of this stock is performed by applying the SS3 model (Methot, 2000) disaggregated by length. This methodology is applied to this stock since it was accepted in the WKFLAT benchmark in 2012 (ICES, 2012) to replace the previous assessment method (ASPIC; Prager, 1994).

The initial WG purpose of investigating in depth the reasons for potential discrepancies was not possible to fulfil with the time available during the WG meeting. However, the results were considered still illustrative regarding the modelling of the technical interactions between stocks and fleets.

#### 4.5.2.2 Mixed fisheries analyses

The full overview of the Fcube projections to 2018 is presented in Table 4.5.2.2 and Figures 4.5.2.2.a to 4.5.2.2.c. The results for 2018 can be compared to each other as in a single-species option table. For ease of comparison, the landings relative to the single stock advice are also presented.

The “**max**” scenario shows the upper bound of potential fleet effort and stock catches and the stock which, to reach its  $F_{MSY}$  target, needs the maximum increase in effort is, according to the current analysis, white anglerfish. However, through assuming that all fleets continue fishing until all their stock shares are exhausted irrespective of the economic viability of such actions, this scenario is generally considered with low plausibility.

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 “**min**” scenario meets this outcome. Additionally, this 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 about 60% of its 2017 level to comply with this scenario, consistent with the reductions in fishing mortality advised for hake, and causing reductions of catches in the remaining species higher than those determined by their respective single stock advice.

Within the scenarios based on each of the stocks, the “**hke**” scenario gives the same result as the “**min**” scenario, showing hake as the choke species. This scenario reflects the target fishing mortality as set for the hake MSY approach; however the results present loss of fishing opportunities for white anglerfish and, in a lesser extent, for megrims. The “**ldb**” and “**meg**” scenarios provide a very similar perspective, giving slight increases in both megrims and doubling the fishing opportunities on hake, but reducing by 30% the prediction of white monkfish landings. Megrims and anglerfishes are mainly caught by bottom otter trawl gears, while hake occurs in the catches of almost all the Iberian métiers. The “**mon**” scenario maintains the single stock advice for white anglerfish, but almost doubles the prediction of both megrims and almost triples the single stock advice for hake.

The “**sq\_E**” scenario provides similar results than the “**ldb**” and “**meg**” scenarios. However, the economic scenario (“**val**”) only provides increases in the advice of hake catches, slightly reducing those of both megrims and leaving in half that of white anglerfish.

#### **4.5.2.2.1 Ancillary stocks**

The revised CFP includes a commitment to introduce a landing obligation (excepting some defined exceptions) in EU demersal fisheries in a phased approach from 2016 until 2019. As such, there is increasing interest in the potential other stocks which may limit fishing activity under the new regulatory regime. The impact of mixed fisheries scenarios on stocks without analytical assessment can be explored by using the respective catch per unit effort values. This approach was not carried out this time; however, further mixed-fisheries analyses could include the Iberian Nephrops Functional Units as well as the ancillary Iberian stocks recently considered by WGBIE: seabass, plaice, pollack, sole and whiting.

#### **4.5.2.2.2 Relative stability**

Relative stability as such is not directly included as an input to the model. Instead, an assumption that the relative landings share of the fleets are constant is used as a proxy, and in the scenarios above, this input was derived from the landing share by fleet and stock in 2016. The landings by national fleets were summed over nation for each scenario, and the share by country was compared with this initial input. The results did not show deviations across all scenarios (Figures 4.5.2.2.2.a to 4.5.2.2.2.d).



**Table 4.3.1.2 Iberian waters: Summary of the 2018 landings and target Fs, resulting from the Advice Approaches considered by ICES. TACs make reference to total catches, as they are used in the assessment model, except for white anglerfish which represent only landings.**

Stocks	TAC 2018	F 2018	SSB 2019	Rational
Hake 8.c-9.a	8561 t	0.25	38286 t	MSY approach
Four-spot megrim 8.c-9.a	1399 t	0.19	8078 t	MSY approach
Megrim 8.c-9.a	292 t	0.19	1519 t	MSY approach
White anglerfish 8.c-9.a	2197 t	0.31	7452 t	MSY approach

**Table 4.4.2.a Métier categories used in the Iberian waters mixed-fisheries analysis.**

Acronym	DCF definition	Description
GNS_DEF_>=100_0_0	Set gillnet targeting demersal fish with mesh sizes larger than 100 mm	Spanish set gillnet (" <i>rasco</i> ") targeting white anglerfish in ICES Division VIIIc with mesh size of 280 mm
GNS_DEF_0_0_0	Set gillnet targeting demersal fish	Artisanal Portuguese fleet using set gillnets
GNS_DEF_60-79_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 60–79 mm	Spanish small set gillnet (" <i>beta</i> ") targeting a variety of demersal fish in north-western Spanish waters
GNS_DEF_80-99_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 80–99 mm	Spanish set gillnet (" <i>volanta</i> ") targeting hake with nets of 90 mm mesh size in north-western Spanish waters
GTR_DEF_0_0_0	Trammel net targeting demersal fish	Artisanal Portuguese fleet using trammel nets
GTR_DEF_60-79_0_0	Trammel net targeting demersal fish with mesh sizes within the range 60–79 mm	Spanish trammel net targeting a variety of demersal species in north-western Spanish waters
LLS_DEF_0_0_0	Set longline targeting demersal fish	Spanish set longline targeting a variety of demersal fish in Spanish Iberian waters
MIS_MIS_0_0_0_HC	Miscellaneous	Portuguese and Spanish artisanal fleet not covered by other metiers
OTB_CRU_>=55_0_0	Bottom otter trawl targeting crustaceans using mesh sizes larger than 55 mm	Portuguese bottom otter trawl targeting Nephrops and rose shrimp
OTB_DEF_>=55_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting hake, anglerfish, and megrim using " <i>bacá</i> " nets of 70 mm mesh size in Divisions 8.c and 9.a
OTB_DEF_>=65_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 65 mm	Portuguese bottom otter trawl targeting demersal fish in Division 9.a
OTB_MCD_>=55_0_0	Bottom otter trawl targeting mixed crustaceans and demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting a variety of fish and crustaceans using nets of 55 mm mesh size in south-western Iberian waters (Gulf of Cadiz and Southern Portuguese waters)

Acronym	DCF definition	Description
OTB_MPD_>=55_0_0	Bottom otter trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting pelagic (horse mackerel, mackerel...) and demersal fish (hake) by using "jurelera" nets of 55 mm mesh size in north-western Spanish waters
PTB_MPD_>=55_0_0	Bottom pair trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	Bottom pair trawl targeting pelagic (blue whiting, mackerel...) and demersal fish (hake) by using nets of 55 and 70 mm mesh size in north-western Spanish waters

**Table 4.4.2.b Iberian waters: Proportion of the stocks total catches (from WGBIE) covered by the WGMIXFISH fleets. A ratio >1 means that the catch information in WGMIXFISH is larger than the information used by WGBIE.**

YEAR	STOCK	WGBIE	WGMIXFISH	DIFFERENCE	RATIO
2017	HKE	18231	15458	2773	0.85
2017	LDB	2349	2296	53	0.98
2017	MEG	487	487	0	1.0
2017	MON	1738	1647	91	0.95

**Table 4.5.2.1.a Iberian waters: Baseline run outputs from the Fcube FLR package.**

Management plan		HKE	LDB	MEG	MON
2017	<b>Fbar</b>	0.65	0.34	0.35	0.21
	<b>FmultVsF16</b>	1.14	1.56	1.65	1.00
	<b>Landings</b>	15458	2296	487	1647
	<b>SSB</b>	26720	8100	1710	8317
2018	<b>Fbar</b>	0.25	0.19	0.19	0.31
	<b>FmultVsF15</b>	0.44	0.88	0.90	1.50
	<b>Landings</b>	7030	1363	293	2202
	<b>SSB</b>	28826	7669	1562	8245
2019	<b>SSB</b>	40155	8059	1519	7162

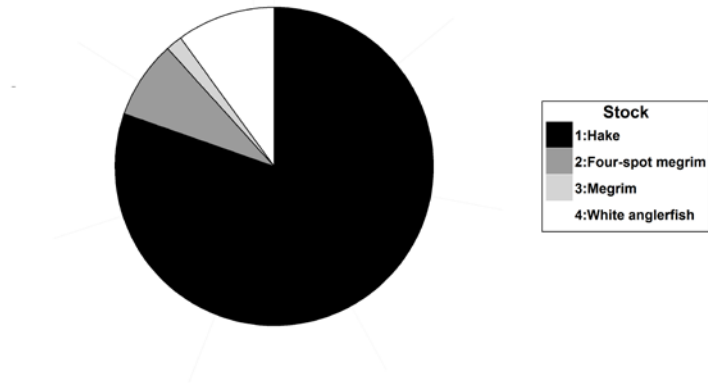
**Table 4.5.2.1.b Iberian waters: Comparison between baseline run and ICES advice. Figures for 2017 compare results from the baseline run - that use the same assumptions for F in the intermediate year as the forecasts leading to ICES advice - to the ICES intermediate year results.**

Management plan		HKE	LDB	MEG	MON
2017	Landings Baseline	15458	2296	487	1647
	Landings ICES	18231	2349	487	1738
	% difference	-15%	-2%	0%	-5%
2018	Landings Baseline	7030	1363	293	2202
	Landings ICES	8561	1399	292	2197
	% difference	-18%	-3%	0%	0%

**Table 4.5.2.2 Results of running Fcube scenarios on the TAC year (2018). Comparison of the single stock ICES advice and potential landings in the various Fcube scenarios.**

Stock	Single-stock catches advice 2018		Catches per mixed-fisheries scenario 2018 relative to the single stock catch advice							
	WGBIE	WGMIXFISH	"Max"	"Min"	"Hke"	"Ldb"	"Meg"	"Mon"	"Ef_Mgt"	"Val"
hke.27.8c9a	8561	7030	2.7	1.0	1.0	2.0	2.1	2.7	2.2	1.3
ldb.27.8c9a	1399	1363	1.7	0.5	0.5	1.1	1.2	1.7	1.3	0.9
meg.27.8c9a	292	293	1.7	0.5	0.5	1.1	1.1	1.7	1.2	0.9
mon.27.8c9a	2197	2202	1.0	0.3	0.3	0.7	0.7	1.0	0.7	0.5

**Total Landings by Stock**



**Figure 4.4.1 Iberian waters: Distribution of landings of the stocks included in the mixed fisheries projections.**

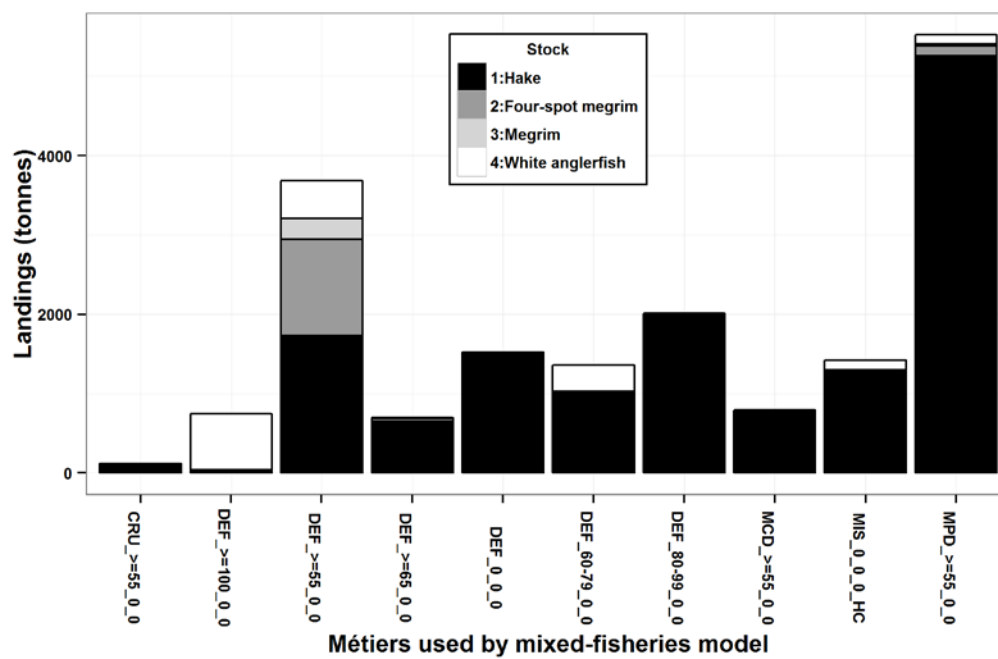
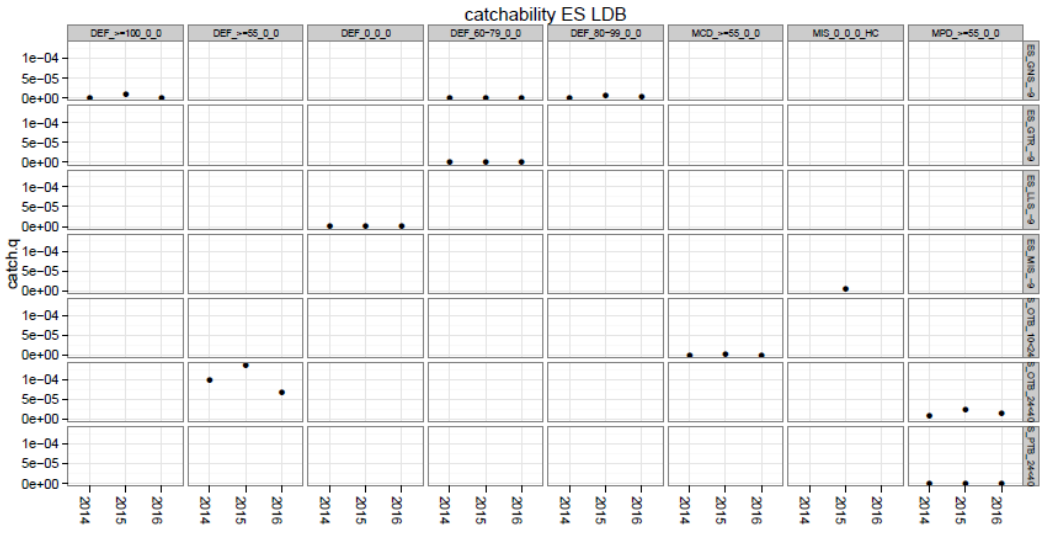
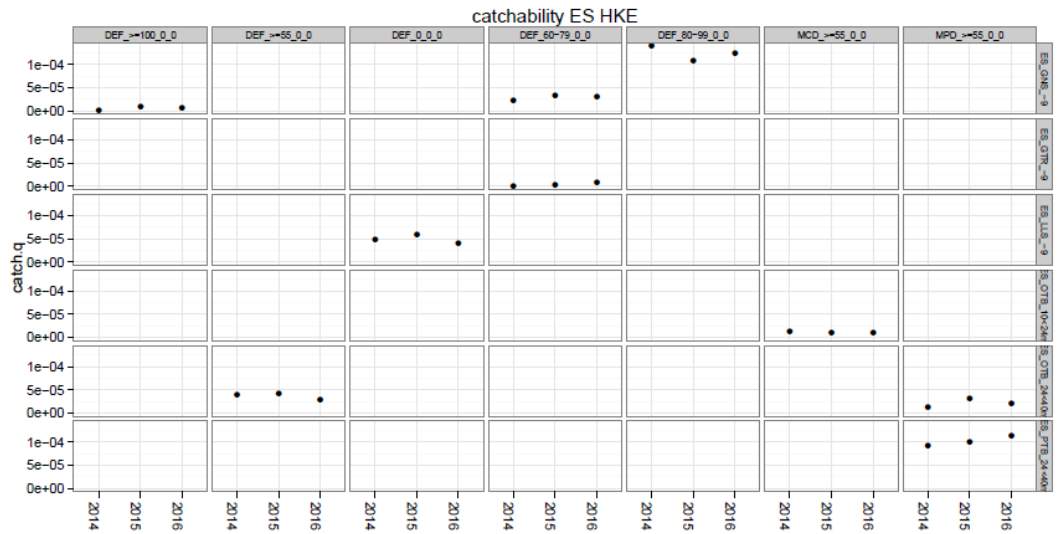


Figure 4.4.2 Iberian waters: Landings distribution of species by métier.



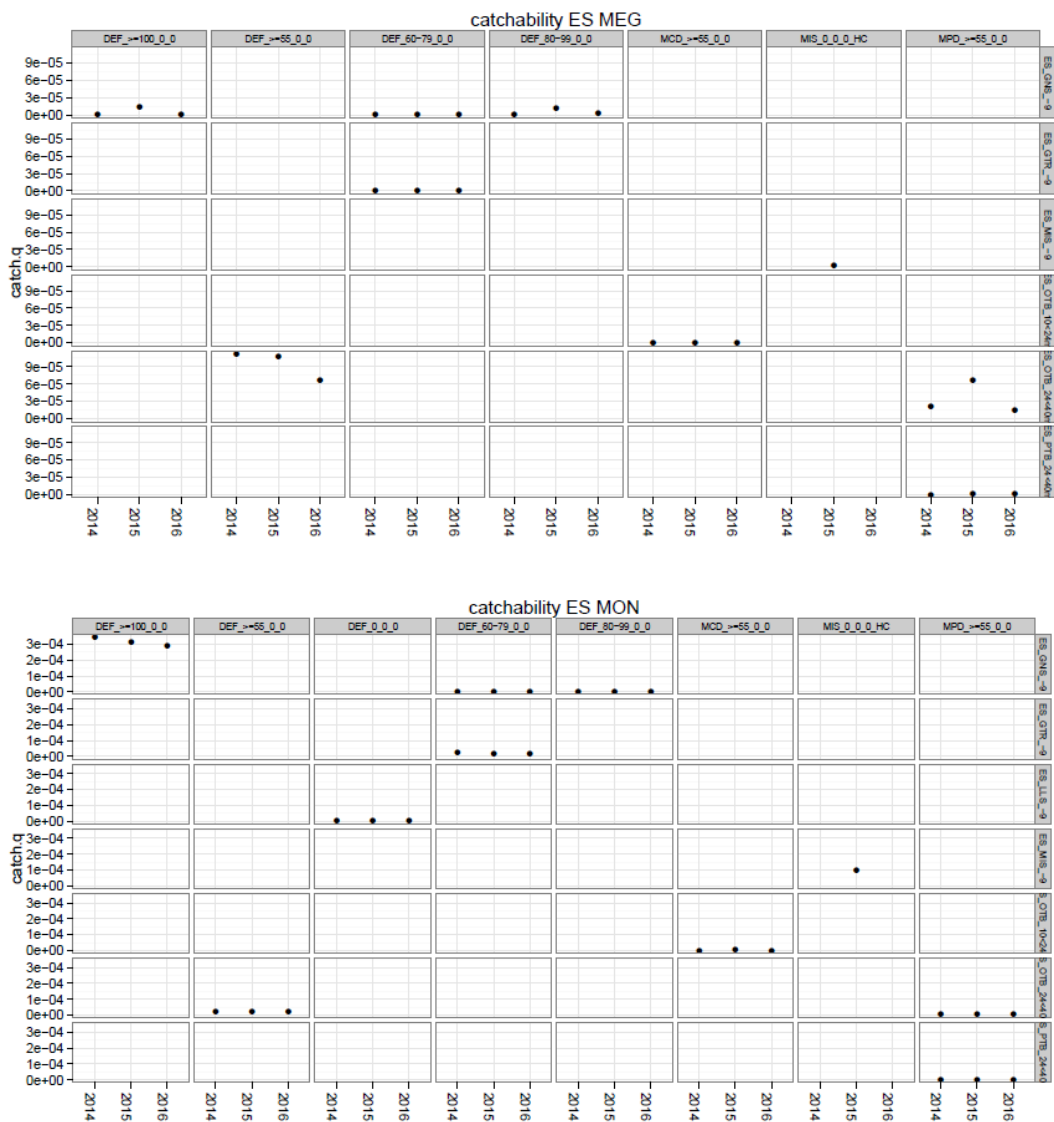
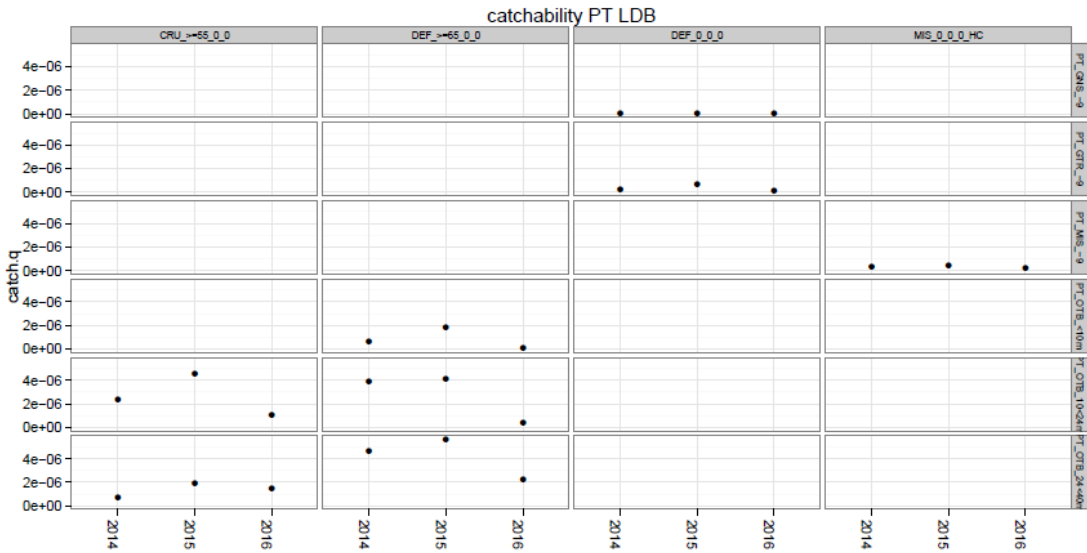
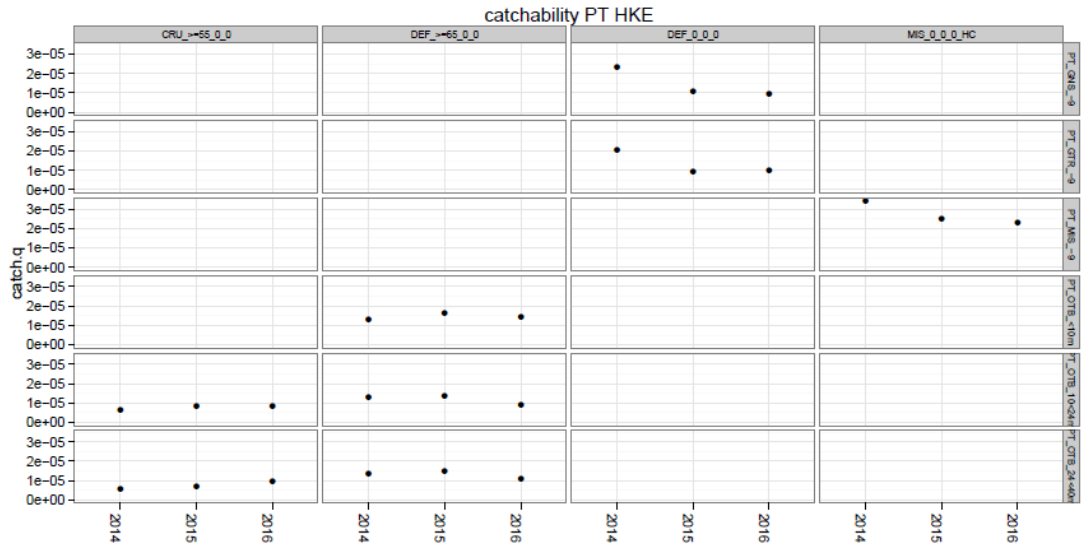


Figure 4.4.3.a Iberian waters: trends of Spanish catchability by stock, fleet and métier.



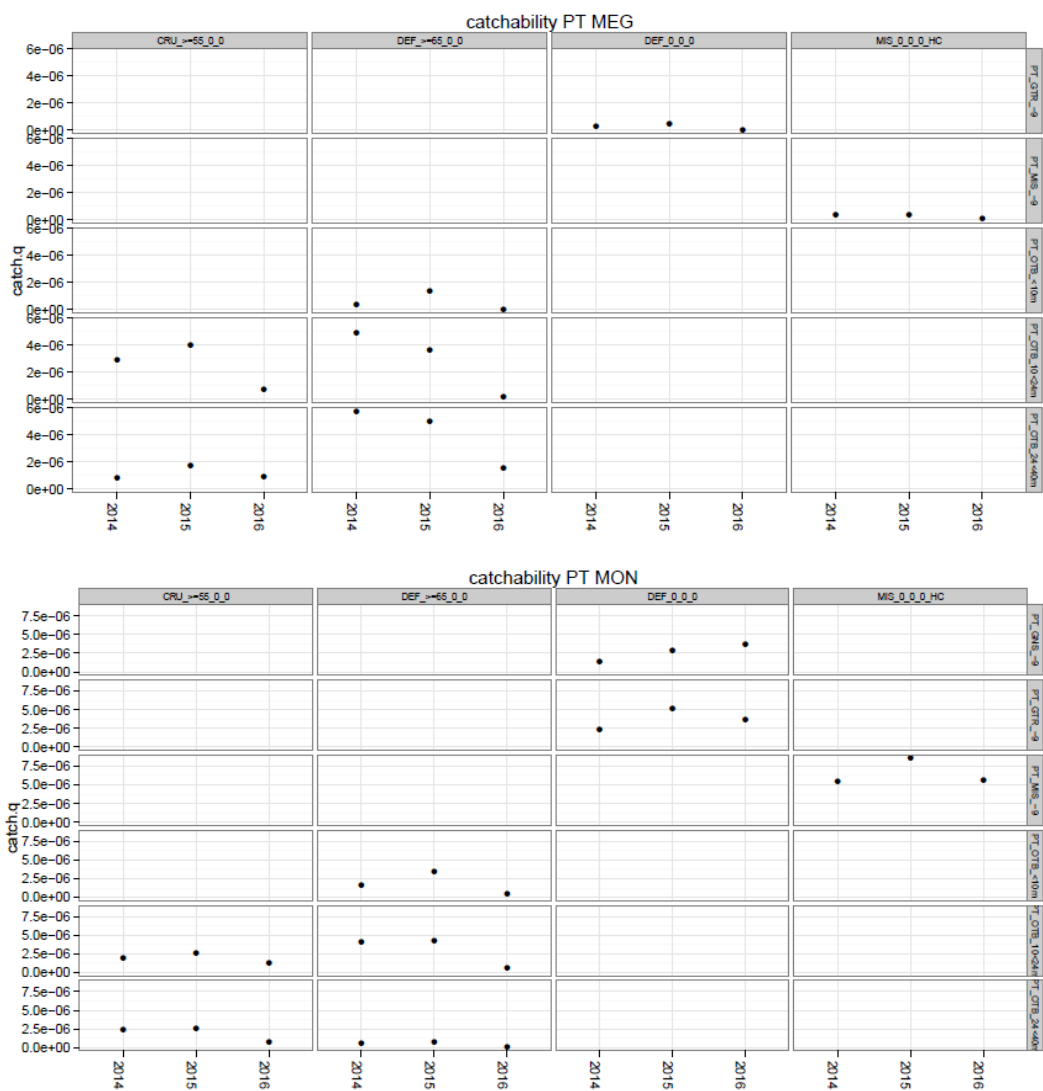


Figure 4.4.3.b Iberian waters: trends of Portuguese catchability by stock, fleet and métier.



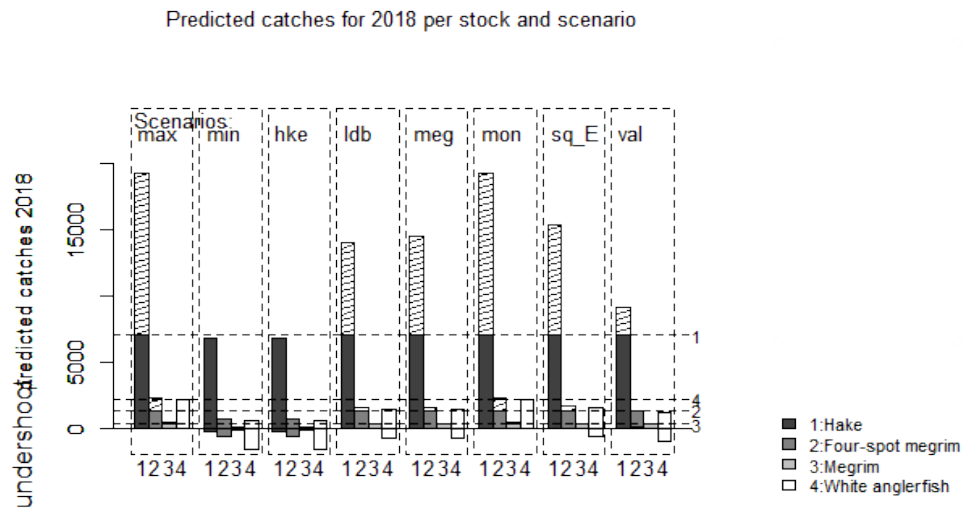


Figure 4.5.2.2.a Iberian waters mixed-fisheries forecasts: TAC year results (2018). Fcube estimates of potential catches by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single stock advice. Bars below the value of zero show the scale of undershoot (compared to the single species catch advice) in cases where catches are predicted to be lower when applying the scenario.

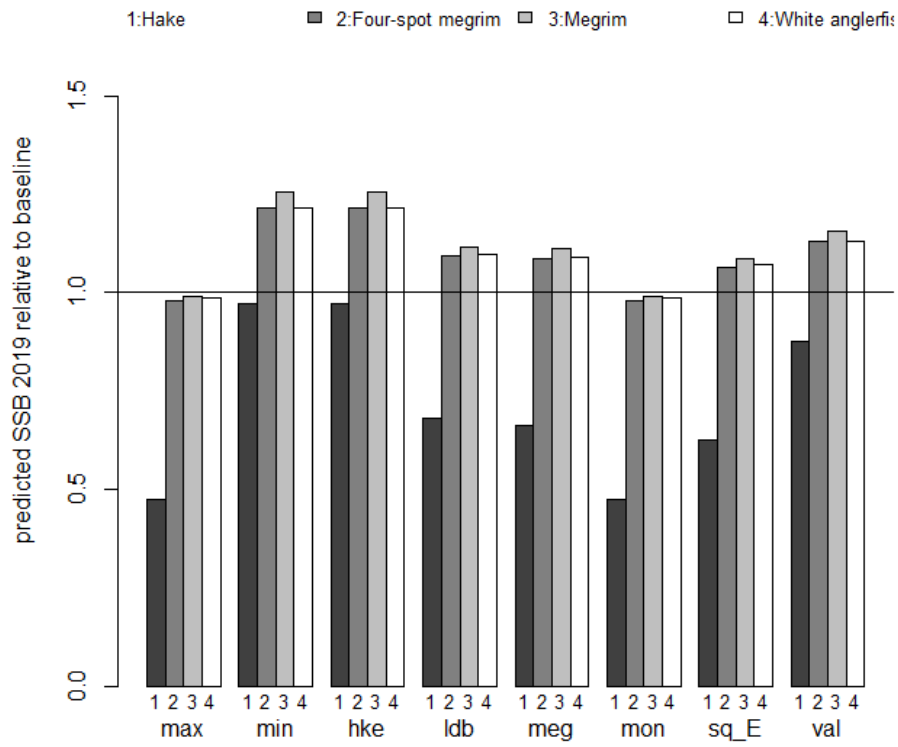


Figure 4.5.2.2.b Iberian waters mixed-fisheries forecasts: Estimates of potential SSB at the start of 2019 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single stock advice (at the start of 2019).

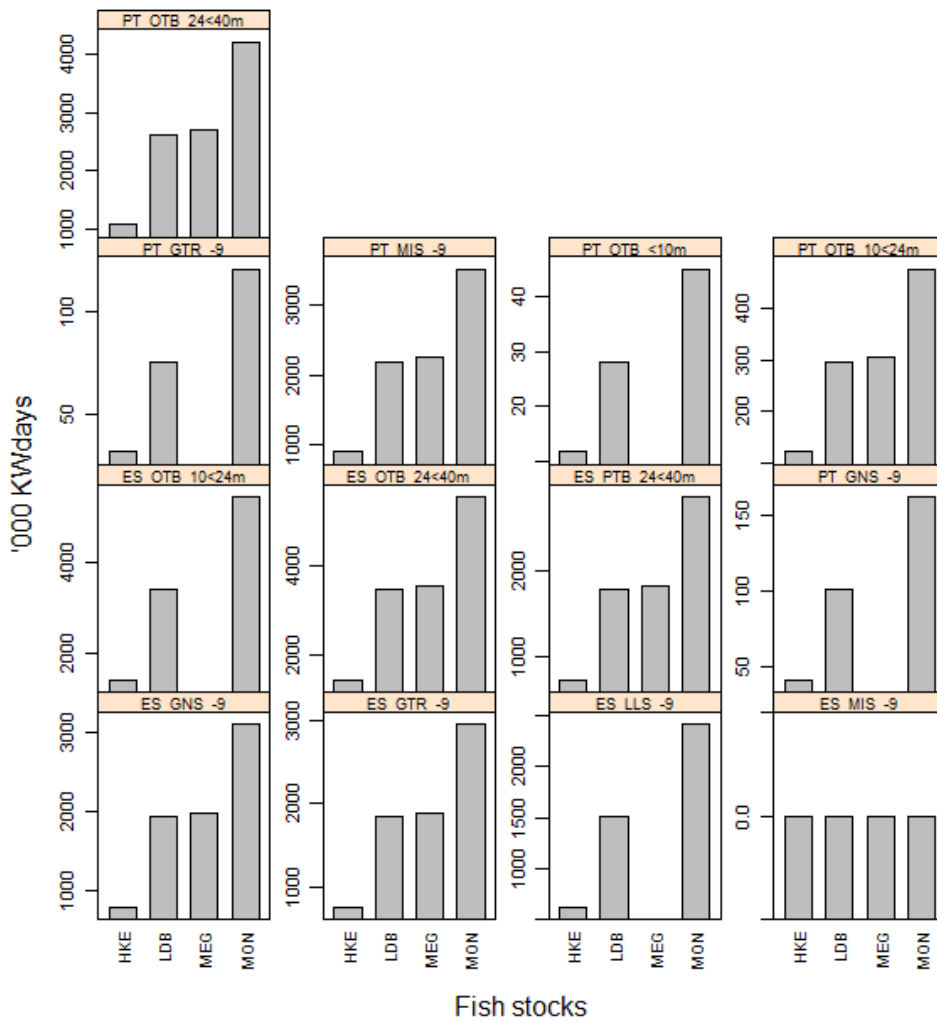


Figure 4.5.2.2.c Iberian waters mixed-fisheries forecasts: TAC year results (2018). Fcube estimates of effort by fleet corresponding to the individual “quota share” (or partial target F) by stock in 2018 (baseline run).

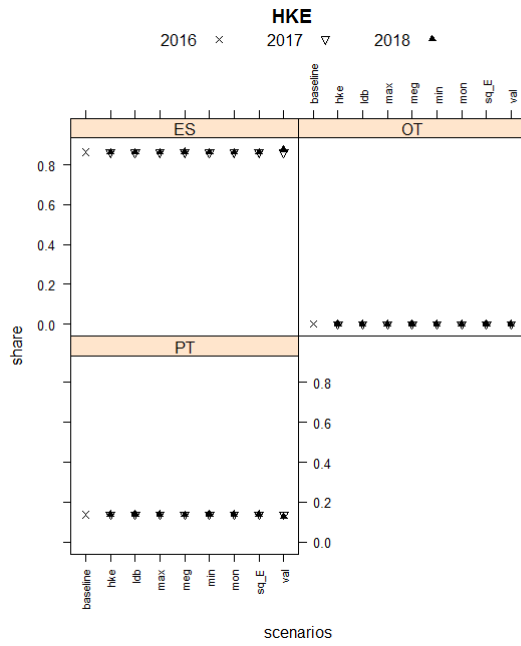


Figure 4.5.2.2.a Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of hake' landings by country in 2017 and 2018 compared to the 2016 share, for the 'baseline' and 8 Fcube scenarios.

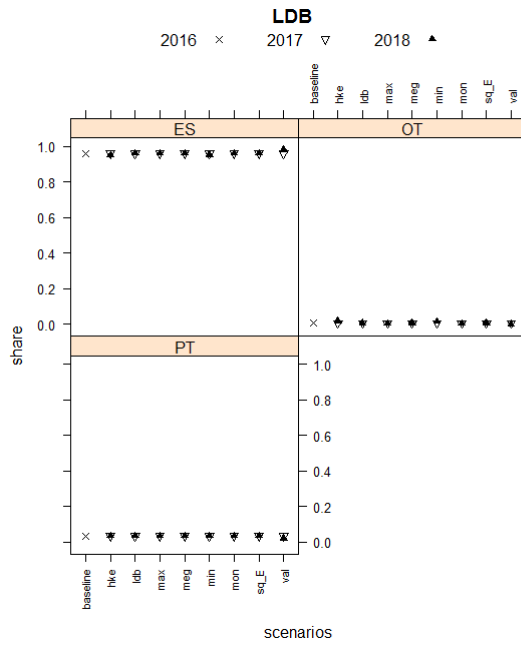


Figure 4.5.2.2.b Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of four-spot megrim' landings by country in 2017 and 2018 compared to the 2016 share, for the 'baseline' and 8 Fcube scenarios.

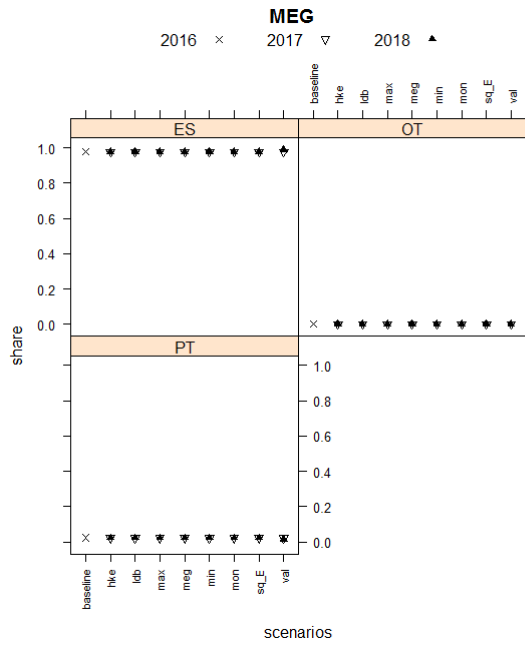


Figure 4.5.2.2.c Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of megrim' landings by country in 2017 and 2018 compared to the 2016 share, for the 'baseline' and 8 Fcube scenarios.

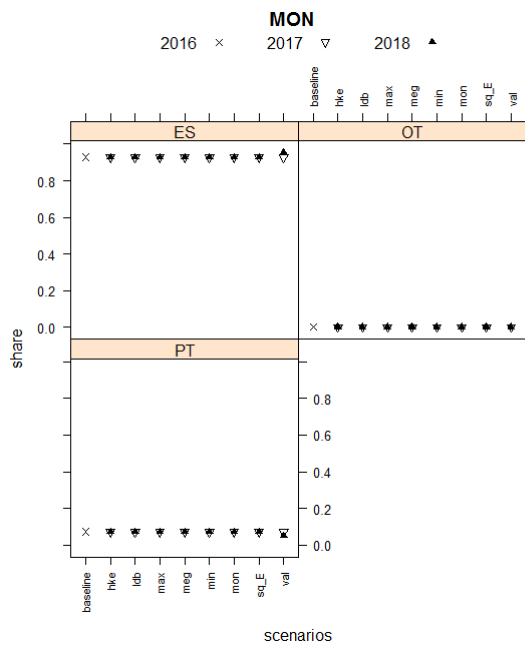


Figure 4.5.2.2.d Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of white anglerfish' landings by country in 2017 and 2018 compared to the 2016 share, for the 'baseline' and 8 Fcube scenarios.

## 5 Additional issues

### 5.1 Introduction of the EU landings obligation

The EU landings obligation for demersal species is since the beginning of 2016 for the demersal fishes in a phased approach with all quota stocks subject to the landings obligation from 2019 onwards, while Norwegian fisheries have been subject to a landing obligation for cod since 1987 and for most finfish species since 2009.

To anticipate this move, since the 2016 working group the mixed fisheries advice was presented in terms of catch (not landings) against the advised single stock catch advice with all the fleets catch counting against the fleets' stock share. This departs from previous advice where the mixed fisheries projections were presented in terms of landings and overshoots or undershoots of the retained portion of the catch, with the assumption that fishing fleets would discard as observed in past years with only the landed portion of the catch counting against the fleets' stock shares.

To account for this difference, the TACs of the different stocks in the TAC year (i.e. Fcube implementation year, 2018) were raised to the total forecast catch from the single stock advice but the fleet stock shares continued to be distributed based on historic landings by the fleets. This change is equivalent to a full and perfect implementation of the discard ban (i.e. all quota species caught must be landed with no exemptions, *de minimis* or inter-species flexibilities) and assumes any uplift in quota is distributed according to past landings shares (consistent with relative stability). The different plan allow for *de minimis* for some fleets given their acceptance by STECF but it is hard to reproduce in the mixed fisheries consideration as it might happen that not whole fleet segment described in the simulation can benefit from the *de minimis*. After several trials of describing as precisely as possible the fleets under *de minimis*, the conclusion was to base the advice on catch and as a consequence, all quota species caught must be landed with no exemptions, *de minimis* or inter-species flexibilities. While the actual proposed implementation of is yet to be decided, and it is unlikely a full discard ban will be in place from 2018, it was considered basing advice on total catch under a full discard ban would highlight the pinch points in the upcoming implementation of the landings obligation. For example, one of the main consequences of a full implementation would be that some fleets with high discards and low landings of a species in the past would now become 'choked' early on in the fishery limiting their catches of other target stock, as the discard species (of which they have a low quota share) would have a greater mismatch between their catches (which now all count again the fleets stock shares) and their stock shares based on historic landings.

It is likely that further developments to the methodology will be required to take account of changes in management and the implementation of the landings obligation in the coming years, and the October WGMIXFISH-METHODS meeting will look specifically at this issue (for example, by progressing age-based mixed fishery forecasting methods).

In addition, methods to include data-limited stocks in the mixed fisheries forecasts based on catch per unit of effort are being developed. This is in order to take account of the potential 'choke' species for fleets operating under a landings obligation.

WGMIXFISH notes that the landing obligation will mean a significant change in the management and therefore exploitation patterns of fleets will most likely change. Predictions of such changes (gear used, areas and times fished) are challenging due to the multitude of economic, social and regulatory drivers and such a fleet behavioral model

is not currently incorporated within the mixed fisheries advice forecast. Changes in fishers behavior will likely lead to an increased uncertainty in MIXFISH forecasts until information becomes available after some years with the landing obligation implemented.

## 5.2 MIXFISH methodology meeting (WGMIXFISH-METH)

Since 2012, a further WGMIXFISH meeting (the ICES Working Group on mixed fishery methods; WGMIXFISH-METH) has taken place in the autumn to develop application of the Fcube methodology to new ecoregions, and to further work on developing new approaches (e.g. age-based forecasts, medium term MSE projections) which could be incorporated into advice for the North Sea. It was agreed that a more general ToR should continue for the WGMIXFISH-METH meeting, to allow development of the current approaches in new ecoregions where expertise is available as well as addressing other methodological issues.

The proposed terms of reference for the WGMIXFISH-METH meeting in October are as follows:

### **WGMIXFISH-METH – Working Group on Mixed Fisheries Advice Methodology**

The Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METH), chaired by Youen Vermard, France, will meet in Nantes, 16–20 October 2017 to:

- a) Review progress on mixed fisheries methodologies and consider how they might be taken forward and incorporated into the advisory process. In particular, focus should be given to the following priorities:
  - 1) Short-term catch forecasting methods, including methods to incorporate data-poor stocks assessed by SPiCT taking account of uncertainties;
  - 2) Incorporation of  $F_{MSY}$  ranges into forecasting procedure to provide advice which minimizes incompatibility between management advice for multiple stocks exploited in mixed fisheries. This may be developed through robust medium term Management Strategy Evaluation approaches,
  - 3) Application of methodology to other ICES regions, fisheries and stocks.

WGMIXFISH-METH will report by 10 November 2017 for the attention of ACOM.

## 6 Conclusions and Recommendations

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WGMIXFISH-ADVICE has produced a draft North Sea Mixed Fisheries advice sheet, a draft Celtic Sea Mixed Fisheries advice sheet, and a draft for Iberian waters for use by ACOM. In addition, much progress was made in developing a Bay of Biscay Mixed Fisheries advice, with the intention of finalising a draft advice sheet in October, after inconsistencies between the single stock forecasts and the mixed fishery baseline runs have been resolved.

This year, the group introduced the ‘range’ scenario. This scenario searches for the minimum sum of differences between potential catches by stock under the “min” and the “max” scenarios within the  $F_{MSY}$  ranges. This scenario aim at reducing the inconsistencies between single stock advices by taking advantages of the  $F_{MSY}$  ranges. However as defined now it implies that some stock are fished under  $F_{MSY}$  and other above  $F_{MSY}$ .

Since 2012, WGMIXFISH-ADVICE is held so that mixed fisheries advice can be available alongside ICES single species advice in June. As in previous years, problems were encountered because of the close proximity of this WG to that of WGNSSK with revisions of single species advice taking place during the North Sea ADG requiring a revised run of the mixed fishery analysis. With the increased number of regions consideration should be given to ensure that sufficient time is available to develop and deliver advice for all these regions. This is particularly true for regions where some of the advice is released in the autumn (e.g. *Nephrops*) where it may be more appropriate to release the mixed fisheries advice at that time. ICES Secretariat and ACOM should consider the optimal time to develop and release the advice, given the timing of the various assessment working groups.

No methodological problems were encountered with the Fcube package with this year’s advice presented in terms of catch rather than landings following some small changes to the Fcube code. This change was in order to reflect that from 2016 the first phase to the implementation of a landings obligation in EU fisheries was due to take place. Further methodological changes are likely to be required in future so that mixed fisheries advice reflects the changing policy and management landscape. The ‘value’ scenario was reintroduced for the North Sea advice as it was considered as appropriate intermediate scenario to reflect potential levels of effort in the fisheries next year given fishing opportunities. Further work should continue to identify a ‘most plausible’ scenario given available fishing opportunities and the management measures in place.

The age version is still under development but couldn’t be finalized during the group. The objective is to be able to finalize it during the autumn group to be able to apply it for the 2018 advice and take into account catch size structures by fleet in the advice and in the context of Landing Obligation.

Given the quantity and complexity of data required for the mixed fishery forecasts, the task of checking data is mainly reliant on the availability of expertise from the countries with significant fleet activity in order to identify any issues based on expert knowledge. For this reason active participation from those with a regional interest in the fisheries, and an understanding of the data is vital to ensure data is as accurate as possible and the context of model outputs can be accurately characterised. The working group encourages participation from those countries with significant interests in the regional fisheries at future working groups.



The group developed under GITLAB a workflow to make the process more transparent and reproducible.

The WGMIXFISH data call requirements are similar to, but separate from, métier-based data submissions to STECF. WGMIXFISH recommends to the RCMs that métier classes be made compatible between the effort, catch and economic datasets requested of nations by STECF as soon as possible to facilitate mixed fishery and bio economic modelling.

## 7 References

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- EU. 2008. COUNCIL REGULATION (EC) No. 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No. 423/2004. Official Journal of the European Union, L 348/21. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0020:0033:EN:PDF>.
- García-Carreras, B., Dolder, P., Engelhard, G. H., Lynam, C. P., Bayliss-Brown, G. A., and Mackinson, S. 2015. Recent experience with effort management in Europe: Implications for mixed fisheries. *Fisheries Research*, 169: 52–59.]
- ICES. 2009a. Report of the Workshop on Mixed Fisheries Advice for the North Sea, 26–28 August 2009, Copenhagen, Denmark. ICES CM 2009\ACOM:47. 62 pp.
- ICES. 2009b. Report of the ad hoc Group on mixed Fisheries in the North Sea (AGMIXNS), 3–4 November 2009, ICES, Copenhagen, Denmark. ICES CM 2009/ACOM:52. 48pp.
- ICES. 2011. Workshop on the analysis of the benchmark of cod in Subarea IV (North Sea), Division VIII (Eastern Channel) and Division IIIa (Skagerrak). ICES CM/ACOM:51.
- ICES. 2013. Report of the Working Group on Mixed Fisheries Advice for the North Sea (WGMIXFISH-NS), 20-24 May 2013, ICES Headquarters, Copenhagen. ICES CM 2013/ACOM:22. 115 pp.
- ICES. 2015. Report of the Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE), 25–29 May 2015, ICES HQ, Copenhagen, Denmark. ICES CM 2015/ACOM:21. 171 pp.
- ICES. 2015a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 28 April-7 May, ICES HQ, Copenhagen, Denmark. ICES CM 2015/ACOM:13. 1031 pp.
- ICES. 2015b. Report of the Working Group on the Assessment of Demersal Stocks in the Celtic Seas (WGCSE), 12 May-21 May, ICES HQ, Copenhagen, Denmark. ICES CM 2015/ACOM:12.
- ICES. 2015c. Report of the Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE), 04-10 May 2015, ICES HQ, Copenhagen, Denmark. ICES CM/ACOM:11. 503 pp.
- ICES. 2017. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9-18 May 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM
- Jardim, Ernesto, Agurtzane Urtizberea, Arina Motova, Chato Osio, Clara Ulrich, Colin Millar, Iago Mosqueira *et al.* 2013. "Bioeconomic Modelling Applied to Fisheries with R/FLR/FLBEIA." JRC Scientific and Policy Report EUR 25823.
- Kell, L., T., Mosqueira, I., Grosjean, P., Fromentin, J.-M., Garcia, D., Hillary, R., Jardim, E., Mardle, S., Pastoors, M. A., Poos, J. J., Scott, F., and R.D. Scott 2007. FLR: an open-source framework for the evaluation and development of management strategies. *ICES Journal of Marine Science*, 64: 640–646.
- Kraak, Sarah B. M., Nick Bailey, Massimiliano Cardinale, Chris Darby, José A. A. De Oliveira, Margit Eero, Norman Graham, Steven Holmes, Tore Jakobsen, Alexander Kempf, Eskild Kirkegaard, John Powell, Robert D. Scott, E. John Simmonds, Clara Ulrich, Willy Vanhee, Morten Vinther. 2013. Lessons for fisheries management from the EU cod recovery plan. *Marine Policy*, 37 (2013): 200-213
- Methot, R. D. 2000. Technical Description of the Stock Synthesis Assessment Program. National Marine Fisheries Service, Seattle, WA. NOAA Tech Memo. NMFS-NWFSC-43: 46 pp.
- Methot, R. D. 2011. User Manual for Stock Synthesis, Model Version 3.23b. NOAA Fisheries Service, Seattle. 167 pp.
- Prager, M. H. 1994. A suite of extension to a non-equilibrium surplus-production model. *Fish. Bull.* 92: 374–389.

- Praguer, M. H. 2004. User's manual for ASPIC: a stock production model incorporating covariates (ver. 5) and auxiliary programs. NMFS Beaufort Laboratory Document BL-2004-01, 25pp.
- R Development Core Team 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.
- STECF. 2013. Scientific, Technical and Economic Committee for Fisheries (STECF) – 44th Plenary Meeting Report. (eds. Casey j. & Doerner H). Office for Official Publications of the European Communities, Luxembourg, ISBN 978-92-79-34654-5, JRC86069, 127 pp. <http://publications.jrc.ec.europa.eu/repository/handle/111111111/29996>
- STECF. 2015. Scientific, Technical and Economic Committee for Fisheries (STECF) – Evaluation of management plans: Evaluation of the multi-annual plan for the North Sea demersal stocks (STECF-15-04). 2015. Publications Office of the European Union, Luxembourg, EUR XXXX EN, JRC XXXX. 152 pp. [http://stecf.jrc.ec.europa.eu/documents/43805/969556/2015-05\\_STECF+15-04+-+NSMAP\\_JRCxxx.pdf](http://stecf.jrc.ec.europa.eu/documents/43805/969556/2015-05_STECF+15-04+-+NSMAP_JRCxxx.pdf).
- Ulrich, C., Reeves, S.A., and S.B.M. Kraak 2008. Mixed Fisheries and the Ecosystem Approach. ICES Insight 45:36-39.
- Ulrich, C., Reeves, S. A., Vermard, Y., Holmes, S. J., and Vanhee, W. 2011. Reconciling single-species TACs in the North Sea demersal fisheries using the Fcube mixed-fisheries advice framework. – ICES Journal of Marine Science, 68: 1535–1547.

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## **Annex 2: Recommendation**

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See Section 6. Conclusions and Recommendations

### **Annex 3: ToRs for next meeting**

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#### **WGMIXFISH-ADVICE – Working Group on Mixed Fisheries Advice**

2017/2/ACOM18 The **Working Group on Mixed Fisheries Advice** (WGMIXFISH-ADVICE), chaired by Youen Vernard, France, will meet at ICES Headquarters 22–26 May, 2018 to:

- a) Carry out mixed demersal fisheries projections for the North Sea taking into account the single species advice for cod, haddock, whiting, saithe, plaice, sole, turbot, *Nephrops norvegicus*, sole 7.d and plaice 7.d that is produced by WGNSSK in May 2017, and the management measures in place for 2017;
- b) Carry out mixed demersal fisheries projections for the Celtic Sea taking into account the single species advice for cod, haddock, and whiting that is produced by WGCSE in 2017, and the management measures in place for 2017 and further develop advice for the region;
- c) Carry out mixed fisheries projections for the Iberian waters taking into account the single species advice for hake, four-spot megrim, megrim and white anglerfish that is produced by WGBIE in May 2017, and the management measures in place for 2017 and further develop advice for the region;
- d) Produce draft mixed-fisheries sections for the ICES advisory report 2017 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, Celtic Sea, and Iberian waters.

WGMIXFISH-Advice will report by 18 June 2018 for the attention of ACOM

## Annex 4: List of stock Annexes

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The table below provides an overview of the WGMIXFISH Stock Annexes. Stock Annexes for other stocks are available on the [ICES website Library](#) under the Publication Type “Stock Annexes”.

STOCK ID	STOCK NAME	LAST UPDATED	LINK
mix.ns	North Sea Mixed Fisheries Annex	May 2017	<a href="#">mix.ns SA</a>
mix.bbi	Iberian Water Mixed Fisheries Annex	May 2015	<a href="#">mix.bbi SA</a>
mix.cs	Celtic Sea Mixed Fisheries Annex	May 2015	<a href="#">mix.cs SA</a>