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Report of the Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)

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Executive summary

The ICES Working Group on Mixed Fisheries Advice [WGMIXFISH-ADVICE] (Chair: Paul Dolder (UK)) met at ICES HQ, 25–29 May 2015 to produce mixed fisheries forecasts for the North Sea, the Celtic Sea and to further work on mixed fisheries forecasts for 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 2016 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 VIId and sole VIId. The impact of mixed fisheries scenarios on seven further stocks; brill, dab, flounder, hake, lemon sole, red mullet, turbot and witch were considered on the basis of catch-per-unit-effort without their incorporation into the mixed fisheries projections.

The most limiting stocks (i.e. the stocks which are the first quota reached for most fleets) in the North Sea demersal mixed fisheries in 2016 were whiting and Eastern Channel sole. If *Nephrops* were to be managed by a separate TAC for individual Functional Units (FUs), *Nephrops* in FU6 (Farn Deeps) was also considered to be limiting for a significant share of the fleets effort. For the first time since the mixed fisheries forecasts have been produced for the North Sea, cod was not the limiting stock. The last limiting stocks (i.e. the stocks which were the last quotas to be fulfilled) were North Sea plaice, Eastern Channel plaice, *Nephrops* in FU7 (Fladen grounds) and haddock.

The meeting produced a North 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. In addition, the meeting updating the mixed fisheries annex.

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 2016 was cod. The least limiting stock (i.e. the stock which was the last quota to be fulfilled) was 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.

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 meeting produced a draft Iberian Waters Mixed Fisheries Advice sheet and mixed fisheries annex, but as there were some discrepancies between the single stock and FCube baseline forecasts that could only be resolved after the meeting, it was decided

not to present the outcomes until the methods meeting in October, at which point the advice sheet will be available for ACOM to review.

Intersessional work addressed the discrepancies found in the single-stock forecasts and successfully implemented the FCube methodology to produce mixed fisheries forecasts for the Iberian waters. It is now considered the implementation is sufficiently progressed so that mixed fisheries advice could be provided for the Iberian waters in 2016.

1 Introduction

1.1 Background

The **Working Group on Mixed Fisheries Advice** [WGMIXFISH-ADVICE] (Chair: Paul Dolder (UK)) met at ICES HQ, 25–29 May 2015 to apply mixed fisheries forecasts to the North Sea, Celtic Sea and Iberian waters single species advice. 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 lead 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, this year 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 starting in 2016.

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:

WGMIXFISH-ADVICE – Working Group on Mixed Fisheries Advice

2014/2/ACOM The **Working Group on Mixed Fisheries Advice** (WGMIXFISH-ADVICE), chaired by Paul Dolder, UK, will meet at ICES Headquarters, 25–29 May 2015.

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 VIId and plaice VIId that is produced by WGNSSK in May 2015, and the management measures in place for 2016;

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 2015, and the management measures in place for 2016; and further develop advice for the region. In particular, it should consider how advice released for *Nephrops norvegicus* issued in October could be taken into account in mixed fisheries projections;

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 2015, and the management measures in place for 2016; and further develop advice for the region. In particular, how advice for Horse mackerel produced by WGHANSA meeting in June 2015 can be incorporated into the mixed fishery forecasts;

d) Produce a draft mixed-fisheries section for the ICES advisory report 2015 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, [and where possible the Celtic Sea and Iberian waters];

WGMIXFISH will report by 12 June 2015 for the attention of ACOM.

2 North Sea

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) 2015/104. The totals in 2015 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

The majority of the stocks considered here as part of the demersal mixed fisheries of the North Sea are subject to multi-annual management plans[1]. These plans all consist 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.

These plans have been discussed, evaluated and adopted on a stock-by-stock basis, involving different timing, procedures, stakeholders and scientists, and as such have never been evaluated in an integrated approach.

In 2015, the assessment for plaice in areas IV incorporated area IIIaN (Skagerrak), which was previously a separate stock, as evidence suggests they should be managed together as a single unit. However, given the small amount of Skagerrak catches compared to the North Sea, the current management plan is still considered appropriate.

The full details and references of these plans are not always easy to find. The most important points of these plans are therefore reproduced in Annex 3.

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 (http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/north-sea-multi-annual/index_en.htm) with potential outcomes of a mixed-fisheries plan evaluated by STECF in March 2015 (http://stecf.jrc.ec.europa.eu/documents/43805/969556/2015-05_STECF+15-04+-+NSMAP_JRCxxx.pdf). Until further progresses are reached with this initiative, the current LTMP are still in effect.

[1] The exceptions are haddock, plaice VIId, sole VIId and the *Nephrops* stocks. For these stocks the ICES MSY approach or Data Limited Stock (DLS) approach is used as the basis of advice.

2.2 Fcube

2.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.* (2007); 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
COD IV, IIIa and VIId	SAM	SAM
HADDOCK IV, IIIa and VIId	TSA	MFDP
PLAICE IV	FLR 2.3, FLXSA	FLR2.3, FLSTF
SAITHE IV, IIIa and VI	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE IV	FLR 2.3, FLXSA	FLR 2.3, FLSTF
WHITING IV and VIId	FLR 2.x, FLXSA	MFDP
PLAICE VIId	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE VIId	XSA	MFDP

2.2.2 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 Mixed Fisheries Annex (Annex 7).

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 2014 data, the match

between InterCatch and fleet data was very good, and age-specific fleet projections will be performed in October 2015 during WGMIXFISH-METH.

As in previous years, the following five 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) **cod**: The underlying assumption is that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.

4) **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) **Ef_Mgt**: The scenario was set up so that métiers controlled by the EU effort management regimes had effort adjusted according to the regimes. Since 2013 all effort totals were left unaltered and the future of effort controls in uncertain. But the WGMIXFISH decided to maintain that scenario, until requested otherwise. The WG implemented the scenario using the assumption that the % change in effort from 2015 to 2016 is the same as the % change in F stipulated under the management plan (-15%).

6) Additionally, the "**Value**" scenario was reintroduced this year. 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 overfishing of some stocks and underutilisation of others

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 × 0.75) + (200 × 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 (2015). 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, TSA for Northern shelf haddock, SCA for North Sea turbot). 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 FU 5, FU6, FU7, FU8, FU9, FU32, FU33, FU34 and *Nephrops* from areas outside the functional units, the ICES advices were taken for the Fmsy approach.

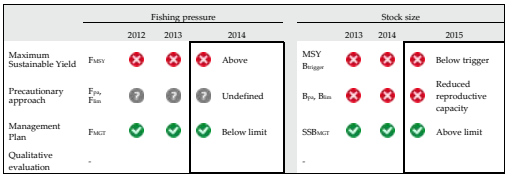
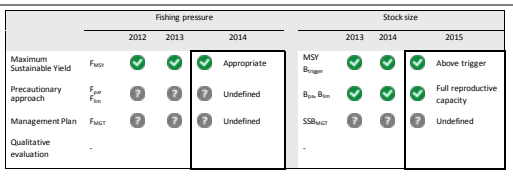
The functional units with separate stock indices from underwater surveys (FU6, FU7, FU8 and FU9) were treated as separate *Nephrops* identities in the projections whereas the five other functional units (FU 5, 10, 32, 33 and 34) and catches outside the functional units in the North Sea were omitted in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

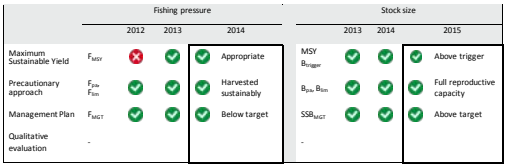
2.3.1.2 Trends and advice

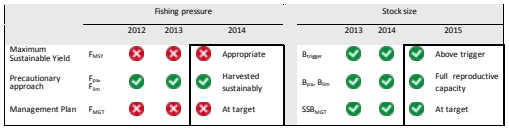
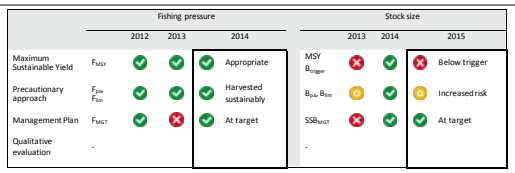
This advice is drafted by the WGNSSK-2015 before considerations by ACOM.

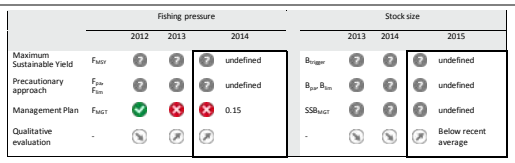
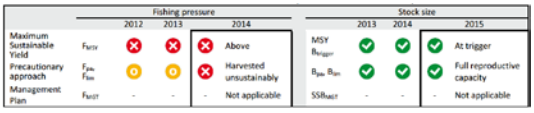
Recent trends are described on a stock-by-stock basis in ICES (2015a), and latest advice by stock is available on the ICES website. In order to give a global overview of all North Sea demersal stocks at one time, this information is summarized below. It should be noted that although there is only one advice, additional management considerations are also listed in the single species advice. Table 2.3.1.2 lists the final advised TACs for 2016 and expected SSBs in 2017.

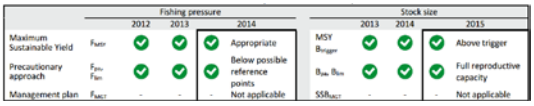
2.3.1.2.1 Analytical stocks

Species	Area	Stock status	Summary	Advice 2016
Cod	Subarea IV (North Sea) and Divisions VIId (Eastern Channel) and IIIa West (Skagerrak)		Fishing mortality (F) declined from 2000 and is now estimated to be around 0.4. Spawning stock biomass (SSB) has increased from the historical low in 2006, and is now above Blim. Recruitment since 2000 has been poor.	ICES advises that when the EU management plan is applied, catch in 2016 should be no more than 51,165 tonnes, and when the EU–Norway management plan is applied, catches in 2016 should be no more than 49,778 tonnes.
Haddock	Subarea IV (North Sea) and Divisions VIId (Eastern		Fishing mortality has been below the estimated fishing mortality rate	ICES advises that when the MSY approach is applied, catches in

	Channel) and VIa (West of Scotland)		for maximum sustainable yield (Fmsy = 0.37) since 2008 and SSB has been above both the lower biomass limit (Blim = 63 000 t) and the precautionary biomass level (Bpa = 88 000 t) since 2008. Recruitment is characterized by occasional large year classes, the last of which was the strong 1999 year class. The 2014 recruitment estimate is higher than recent poor recruitment years, but is still below the long-term average.	2016 should be no more than 74 854 tonnes.
Plaice	Subarea IV (North Sea) and Division IIIa West (Skagerrak)		Skagerrak is now assessed together with the North Sea. The combined North Sea and Skagerrak stock is well within precautionary limits, has increased in the past ten years, and reached a record-high level. Recruitment has been around the long-term average since the mid-	ICES advises that when the second stage of the management plan (Council Regulation No. 676/2007) is applied, catches in 2016 should be no more than 213 440 tonnes in division IV and IIIa combined.

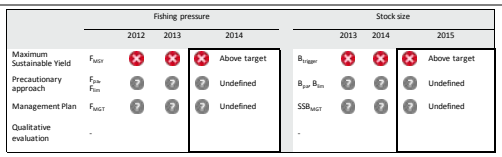
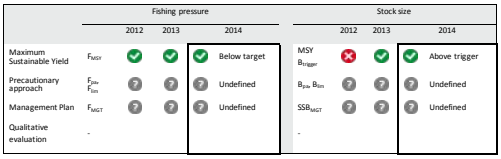
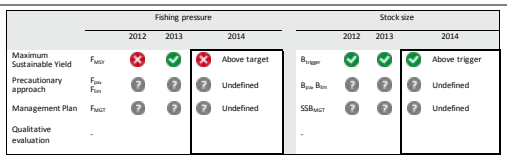
			2000s. In recent years, fishing mortality has been estimated below FMSY and below the target specified in the management plan.	
Sole	Subarea IV (North Sea)		The North sea stock is well within precautionary limits. The SSB has been increasing since 2010 and is estimated to be above Bpa in 2015. Fishing mortality has steadily declined since 1997 and is estimated to be just above FMSY in 2014.	ICES advises that when the second stage of the EU management plan (Council Regulation No. 676/2007) is applied, catches should be no more than 12 835 tonnes.
Saithe	Subarea IV (North Sea) and Divisions IIIa (Skagerrak) and Subarea VI (West of Scotland and Rockall)		Recruitment has been below average since 2006. Fishing mortality has fluctuated around the fishing mortality rate associated with maximum sustainable yield (FMSY) since 1997. SSB has declined and has been fluctuating around the precautionary biomass limit (Bpa) since 2011.	ICES advises on the basis of the EU–Norway management plan that catches in 2016 should be no more than 75 049 t.

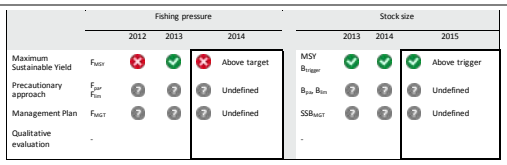
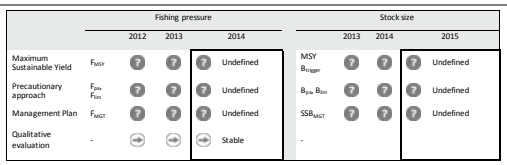
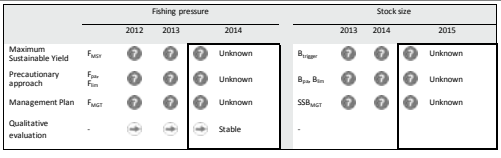
Whiting	Subarea IV (North Sea) and Division VIId (Eastern Channel)		SSB has a generally downwards trend since the start of the assessment time-series, although in 2015 SSB was estimated to increase slightly. Fishing mortality has been declining over most of the time-series, with a small increase in recent years. The level of recruitment has been generally low since 2003, with recruitment in 2015 above the average of the recent years.	ICES advises that when the EU–Norway management plan is applied, total catches in 2016 should be no more than 25 000 tonnes.
Sole	Division VIId (Eastern Channel)		The spawning-stock biomass (SSB) has fluctuated without trend and is above the MSY biomass reference point (MSY Btrigger) since 2002. Fishing mortality has always been above the MSY fishing mortality reference point (FMSY), and increased in 2013 and 2014. Recruitment has been	ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 2 660 t.

			fluctuating without trend. Recruitment in 2012 and 2013 are the lowest of the time series.	
Plaice	Division VIId (Eastern Channel)		Fishing mortality has declined since the mid-1990s and is presently among the lowest in the time-series. Spawning-stock biomass has increased since 2008 and is currently around the highest level.	ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 19883 tonnes. Assuming the same proportion of the Division VIIe and Subarea IV plaice stocks is taken in Division VIId as during the last decade (2003–2015), this will correspond to catch of resident plaice in Division VIId of no more than 17250 tonnes.

2.3.1.2.2 Nephrops stocks

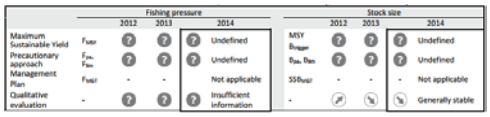
SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Nephrops	Botney Gut-Silver Pit (FU 5)	**Fishing pressure** 2011–2013 **MSY** (F_{MSY}) Unknown **Precautionary approach** (F_{pa}, F_{lim}) Unknown **Qualitative evaluation** Below possible reference points **Stock size** 2011–2013 **MSY** ($B_{trigger}$) Unknown **Precautionary approach** (B_{pa}, B_{lim}) Unknown **Qualitative evaluation** Above poss. reference points	The state of this stock is unknown. Preliminary stock surveys (2010 and 2012) indicate relatively high density compared to neighbouring FUs, which, when	ICES advises on the basis of ICES approach to data-limited stocks that catches should be no more than 1159 t. If discard rates do not change from

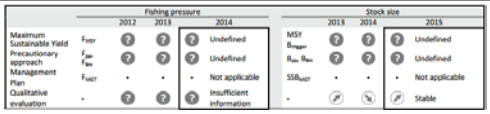
			compared to estimated landing numbers imply harvest rates considerably below those associated with MSY for other North Sea Nephrops stocks.	the assumed rate of 25%, this implies landings of no more than 1043 t.
Nephrops	Farn Deeps (FU 6)		The stock size has declined since 2005 and has been fluctuating near MSY Btrigger since 2007. Harvest rates have been above FMSY for all years except 2008.	ICES advises that when the MSY approach is applied catches in 2016 (assuming a landing obligation applies) should be no more than 1303 t.
Nephrops	Fladen Ground (FU 7)		The stock size has declined from the highest observed value in 2008 and is just above the MSY Btrigger. The harvest rate has declined in recent years and remains well below FMSY.	ICES advises that when the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 8549 t.
Nephrops	Firth of Forth (FU 8)		The stock size is above the MSY Btrigger level. The harvest rate increased in 2014 to 29.1% and is now above FMSY.	ICES advises that when the of the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 1316 t

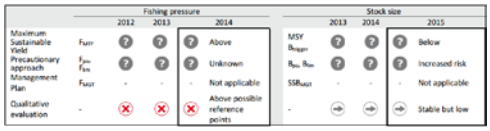
Nephrops	Moray Firth (FU 9)		The stock has declined since 2007 and has been fluctuating without trend since 2012. The harvest rate increased in 2014 to 14.7% and is now above FMSY.	ICES advises that when the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 943 t.
Nephrops	Noup (FU 10)	**Fishing pressure** **2011–2013** **MSY (F_{MSY})** Unknown **Precautionary approach (F_{pa},F_{lim})** Unknown **Qualitative evaluation** Below possible reference points **Stock size** **2011–2013** **MSY ($B_{trigger}$)** Unknown **Precautionary approach (B_{pa},B_{lim})** Unknown	The state of the stock is unknown. UWTV surveys in FU 10 have been conducted sporadically and indicated that the density is relatively low (0.1 Nephrops m−2). Landings in FU 10 are at a historical minimum, suggesting harvest rates below those associated with MSY for other North Sea Nephrops stocks.	ICES advises that when precautionary approach is applied, catches in 2016 should be no more than 33 t. If discard rates do not change, this implies landings of no more than 32 t.
Nephrops	Norwegian Deep (FU 32)		The state of this stock is unknown. Based on the assumed low density (based on lowest observed density at FU 7, Fladen Ground), harvest rates are considered low for this stock.	ICES advises that when the MSY approach is applied, catches in 2016 (assuming a landing obligation applies) should be no more than 642 t.
Nephrops	Horn's Reef (FU 33)		The state of this stock is unknown. Based on the assumed low density (based	ICES advises that when the MSY approach is applied, catches in

			on lowest observed density at FU 7 (Fladen Ground), harvest rates are considered low for this stock.	2016 (assuming a landing obligation applies) should be no more than 1418 t.
Nephrops	Devil's Hole (FU 34)	**Fishing pressure** **2011–2013** **MSY (F_{MSY})** ? Unknown **Precautionary approach (F_{pa},F_{lim})** ? Unknown **Stock size** **2011–2013** **MSY ($B_{trigger}$)** ? Unknown **Precautionary approach (B_{pa},B_{lim})** ? Unknown **Qualitative evaluation** ↘ Declining	The state of the stock is unknown. The mean survey density indicates the stock is declining. No survey information is available for 2013.	ICES advises that when precautionary approach is applied, on the basis of ICES approach to data-limited stocks that catches in 2016 should be no more than 410 t. If discard rates do not change from the recent average of 4 years (2008–2011), this implies landings of no more than 383 t.

2.3.1.2.3 Ancillary stocks

Species	Area	Stock status	Summary	Advice 2016
Brill	Subarea IV (North Sea) and Divisions IIIa (Skagerrak), VIId and VIIe (English Channel)		Landings have fluctuated without trend since 1998 and have been below the maximum allowed ICES advice in 2013 and 2014 (the first years for which numerical advice was issued for this stock). Discarding in 2012-2014 ranged between 4 and 8% of the total catch. The stock size indicator (corrected lpue from the Dutch beam trawl fleet > 221 kW) in the last two years (2013–2014) is 6% lower than the average of the three previous years (2010–2012). Commercial lpue may be also influenced by the turbot uptake of the TAC.	ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 2100 tonnes.
Dab	Subarea IV (North Sea) and Division IIIa (Skagerrak)	Not available	Landing data are not complete before 1998 and are not indicative for catches since discard rates are high. Official landings were below the	ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 76075 tonnes.

			advised landings in 2013 and 2014. Survey indices show a highly variable abundance trend on a rather high level for the last decade in Subarea IV which is the main part of the distribution area. The stock size indicator (mature biomass kg/hour) in the last two years (2014–2015) is 40% higher than the average of the three previous years (2011–2013).	
Flounder	Subarea IV (North Sea) and Division IIIa (Skagerrak)		The available survey information indicates a rather stable stock abundance trend between 2005 and 2011, but shows a decline between 2012 and 2014. Landings declined in recent years in both areas (IV, IIIa). The stock size indicator (mature biomass/hour) for the whole area in the last two years (2014–2015) is 9% lower than	ICES advises that when the precautionary approach is applied, catches in 2016 should be no more than 3254 tonnes.

			the average of the previous three years (2011–2013).	
Turbot	Subarea IV (North Sea)		Recruitment is variable without a trend. Fishing mortality (F) is estimated to have increased over time. Spawning-stock biomass (SSB) has decreased and in recent years has stabilised at a low level.	ICES advises that when the precautionary approach is applied, catches should be no more than 1995 tonnes in each of the years 2016 and 2017. If discard rates do not change from 2014, this implies landings of no more than 1925 tonnes

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. The process and the quality of data have continuously improved over time.

In 2015, ICES generalized the data call to most stocks and regions. As a result, the data collation process went much smoother than any time before. Data were provided on time and in the right format, and with only few exceptions, the métiers were consistently used between the InterCatch data and the MIXFISH data.

However some inconsistencies remained in some Norwegian effort data which could not be resolved during the working group and 2014 Norwegian effort was assumed to be equivalent to 2013[2].

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

[2] Extensive investigation following the meeting could not identify any data reason for the inconsistencies.

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 (>=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.

As previously, data for 2009 was not available from France and had to be assumed equal to 2008 values. Points of note regarding data by nation are contained in Annex 2 of the report.

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;

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

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 weight 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 2015, 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 2014) 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 2015, the final data used contained 39 national fleets (plus the OTH fleet) from nine countries, from 2003 to 2014. 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 (Figure 2.4.2.c and table 2.4.2.b). Some landings may not be allocated to fleets, due to for example missing countries or areas (e.g. area VIa 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 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:

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 WGNSSK are performed using different software and setups (see 3.1.3 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.

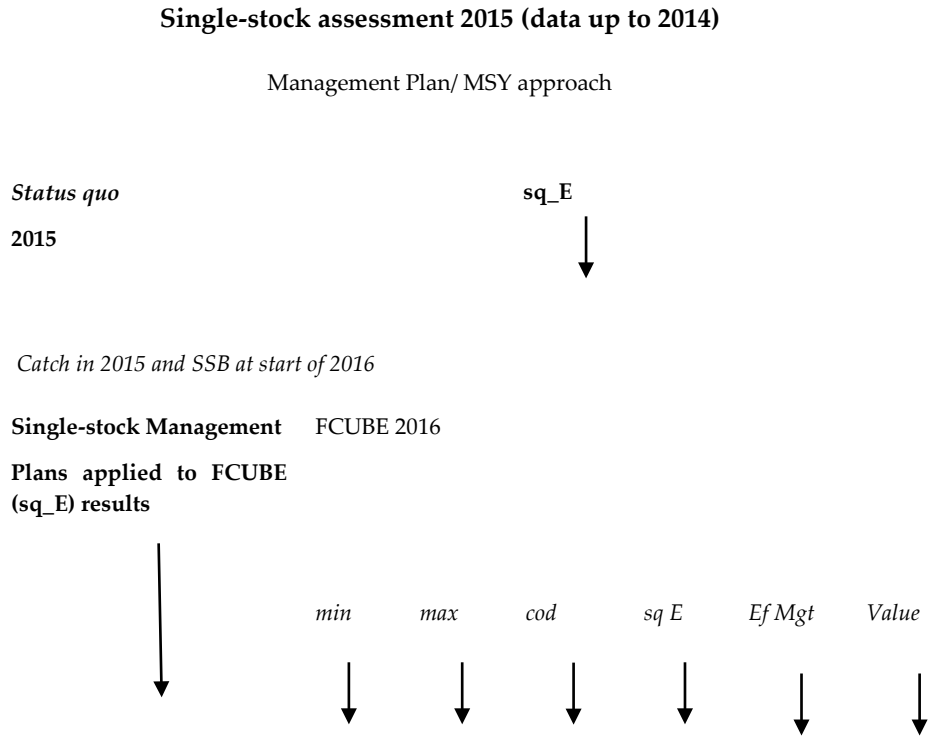
However, since 2013, the working group adopted a forecast approach for the intermediate year on the basis of *Status quo* effort. As a roll-over of effort limitations from the cod management plan has been adopted by the EC since 2013, a *status quo* effort assumption is considered a plausible assumption 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). Therefore the mixed fishery analysis used a *status quo* effort assumption for the intermediate year (2015), with the Fcube scenarios used for the TAC year (2016).

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 2016 (i.e. all quota species caught must be landed, with no exemptions, *de minimis* or inter-species flexibilities) . The TAC was lifted up with the 2014 discards estimates for cod, haddock, plaice, whiting and Nephrops, 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 2016, 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 (such as whiting) 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:



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 2016, displaying at once which stocks have an advice expecting a reduction in F (and thus in effort) and which have an expected increase. Sole and whiting 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 entire basis for North Sea assessment and forecast was changed from the B-Adapt to the SAM assessment package in early 2011 (ICES WKCOD 2011), and this had important consequences for the WG's ability to reproduce it in Fcube. The cod forecast is produced internally in the SAM assessment method using 1000 stochastic replicates drawn within the confidence interval of the F, N 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 forecast includes some uncertainty factors in the relationship between N and F, and the SAM median does not follow exactly the catch and survivors equations.

In 2015, the F assumption in the intermediate year was *status quo* F on the basis that there has been no reduction in effort ceiling since 2013. 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.

Historically, the projections for cod have always been constrained by the 20% TAC cap of the management plan, implying no differences in the single-species and mixed-fisheries estimates. This year, the single-species advice was not constrained, and therefore some small differences were observed (−2.2% in estimated landings in 2015, and −2.4% in 2016; −5.8% difference in SSB in 2017). Nevertheless, the FLR 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 methods developed in WGNSSK to parameterize future selectivity and weight-at-age for haddock are sometimes quite specific and do not always follow common standards, and therefore some input data had been entered manually rather than through automation. Afterwards the results were very similar to a −0.9% discrepancy between SSB projections in 2016 and a −0.4% difference for 2017. Forecast landings in 2015 showed a –1% difference and in 2016, a 1.1% discrepancy. The FLR forecast was considered sufficiently close for use in the mixed-fisheries projection.

Whiting: There were issues replicating the future selectivity and weight-at-age for whiting, therefore selectivity information was entered manually and catch weights were recalculated. In addition, discrepancies between WGMIXFISH and WGNSSK forecasts in landings may be attributed to differences in the way the industrial bycatch is handled by the two approaches. In the WGNSSK forecast this is handled as a separate fleet with a fixed multiplier, whereas in the FLR forecasts, it is included within the landings component. The difference in landings was −0.3% for 2015 and +2.3% for 2016; this was not considered significant in terms of outturn results. Discrepancies in SSB in 2016 and 2017 were 0.1%.

Saithe: Straightforward, no problems encountered.

North Sea Plaice: Straightforward, no problems encountered.

English Channel Plaice: The forecast was complicated by the fact that there is known to be significant migration of plaice between the North Sea, Eastern Channel and Western Channel; the forecast (and assessment) attempts to take account of the expected quantity of plaice caught in the eastern channel adjusting for these migrations. Nevertheless, there were no problems encountered.

North Sea Sole: Straightforward, no problems encountered.

North Sea Sole: Straightforward, no problems encountered.

English Channel Sole: Straightforward, no problems encountered.

Turbot: This stock had been included for the first time in 2014. But important issues and uncertainties in the final assessment results led to this stock being removed from mixed-fisheries projections in 2015.

***Nephrops*:** The forecasts applied the recommended harvest rates to the most recent abundance estimates available for the relevant FUs; hence the process replicated precisely the ICES advice for all but 3 stocks (NEP6, NEP8, and NEP9; with differences in landings ≦ 1.6%).

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 2015 TAC applied to the abundance estimates in 2015 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 2015 is not used in the forecasts for 2016.

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 2016 is presented in Table 2.5.2.2.a and Figures 2.5.2.2.a – 2.5.2.2.c. The results for 2016 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.

For example, the baseline run for **cod**, which follows the single-stock ICES advice, assumes landings of 42 394 tonnes in 2014 (F2015 assumed to equal F2014), and catches of 49 259 tonnes in 2016. The resulting SSB in 2017 is estimated to be 187 263 tonnes. WGMIXFISH assumes *status quo* effort (**sq_E**) in 2015 resulting in a slight increase in F compared to 2015 and landings of 44 325 tonnes in 2015. If it is assumed the **sq_E** scenario was used as the basis for the single species advice instead of the actual single species basis the MSY strategy would lead to TAC advice of 47 128 tonnes, representing the same F value but applied to a smaller biomass than in the baseline. The resulting SSB in 2017 is estimated to be 172 550 tonnes, 8% lower than the resulting SSB following the single species advice according to the cod Management Plan.

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. For the first time, cod was not estimated to be the most limiting stock in the "Minimum" scenario. For 2016, 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), whiting and Eastern Channel sole would be the most limiting stocks, constraining 46% (19 fleets) and 17% (6 fleets) of the 2014 effort, respectively. Additionally, if *Nephrops* was managed by separate TAC for the individual functional units (FU), *Nephrops* (FU 6) would be limiting for 34% (12 fleets) of the 2014 effort. Cod and North Sea sole would each limit 2% of the effort.

Conversely, the least limiting stocks are North Sea plaice, Eastern Channel plaice, *Nephrops* (FU 7), and haddock, for fleets representing 46% (19 fleets), 34% (13 fleets), 12% (3 fleets), and 8% (5 fleets) of the effort in 2014, respectively.

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. Fishing effort should be reduced by 55% of its 2014 level to comply with this scenario, consistently with the reductions in fishing mortality advised for whiting, Eastern Channel sole, and *Nephrops* (FU 6).

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.

Four 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 × 0.75) + (200 × 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 "Cod" scenario reflects the fishing mortality corresponding to the single-stock advice for cod (based on the ICES MSY approach), and the results present fishing opportunities for other stocks in a mixed-fisheries context. According to the single-stock advice, a reduction of 17.5% in cod F is required (from 0.40 in 2015 to 0.33 in 2016). In this scenario it is assumed that effort reductions in fleets (to achieve new partial Fs) apply equally to all fleets with any cod catch, 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 "Cod" scenario is considered here because cod has systematically been the limiting species since the beginning of mixed-fisheries analysis in 2006. For the first time in a decade, cod has not been estimated to be the most limiting stock.

The "Effort management" scenario presents the expected outcome if (a) the nominal effort reductions stipulated in the effort management plans were translated in full into actual effort cuts and (b) a 1:1 relationship existed between fleet effort and mean F. As for 2015, effort reductions were assumed to apply to EU TR1 and TR2 gear types. The data used for the mixed-fisheries projections show that effort reductions to date have

been less than those stipulated in the fishing opportunities regulations, and studies have indicated that the strength of linkages between effort and F differ depending on fleet and species (STECF, 2013; García-Carreras *et al.*, 2015). Equally, the projections assume that the catchability remains constant, which does not take account of changing vessel behaviour in 2015 and 2016 because of e.g. real-time closures or technical measures. The effort reduction from 2015 to 2016 was simulated here to be 15%, which is in line with the reduction in F stipulated by Council Regulation (EC) 1342/2008, Art. 8.4.b (EU, 2008). However, the effort reductions stipulated under the cod management plan have not been implemented in the past three years.

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. The decrease in the 2016 single-stock advice for Eastern Channel sole is restrictive for the fishery at *status quo* effort.

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 2015. 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 2015 with the mixed-fisheries catch estimates.

The anticipated SSBs in 2017 of the Fcube scenarios are shown in Figure 2.5.2.2.c. North Sea sole and Eastern Channel sole suffer the greatest shortfalls in SSB compared to the level predicted compatible with their single species advice if *status quo* effort and catchabilities are assumed (**sq_E** scenario).

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 sole are the limiting species for many of the fleets, and cod the remainder.

2.5.2.2.1 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 other stocks which may potentially limit fishing activity under the new regulatory regime. The impact of mixed fisheries scenarios on eight further stocks; brill, dab, flounder, hake, lemon sole, red mullet, turbot and witch were considered without their incorporation into the mixed fisheries projections. The working group considers technical issues prevent these stocks from being incorporated into the mixed fisheries projections but, using catch per unit effort measured in 2014, catches of these stocks were calculated once the mixed fisheries projections had determined fleet effort levels in order to provide an indication of the levels of under- and over-quota landings of these stocks under a plausible range of effort levels.

Figure 2.5.2.2.1 shows the outcome. All TACs of these stocks except the North Sea component of the hake TAC and lemon sole were predicted to be underutilized under assumption of *status quo* effort, while hake quota was predicted to be fully utilised under the '**min**' scenario, highlighting its potential as a 'choke' species for the fisheries.

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 2014. 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 2.1.1, Mixed-fisheries advice North Sea. Effort reductions in 2015 compared to 2014, by EU-regulated fleet segment (Council Regulation (EC) No. 2015/104), and the assumed reduction between 2016 and 2015 for the "Effort" scenario.

Gear description	Code	% effort reduction in 2015 compared to 2014	% effort reduction in 2016 compared to 2015
Bottom trawls and seines ≥ 100 mm	TR1	0%	15.0%
Bottom trawls and seines ≥ 70 mm and < 100 mm	TR2	0%	15.0%
Bottom trawls and seines ≥16 mm and < 32 mm	TR3	0%	0%
Beam trawls ≥ 120 mm	BT1	0%	0%
Beam trawls ≥ 80 mm and < 120 mm	BT2	0%	0%
Gillnets and entangling nets, excluding trammelnets	GN1	0%	0%
Trammelnets	GN1	0%	0%
Longlines	LL1	0%	0%
Non-regulated gear	None	0%	0%

Table 2.3.1.2 Summary of the 2016 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) – 2015	Catch – advice for 2016	Wanted catch – advice for 2016	F/Harvest ratio for 2015	F/Harvest ratio for 2016	SSB 2016	SSB 2017	Rational
Cod IIIa-IV-VIId	4271 + 29 189 + 1701 = 35 161 (IIIa+IV+VIId)	< 49 259 t	< 40 419 t	0.40	0.33	163 565 t	187 263 t	MSY approach
Haddock IIIa-IV-VIa	2504 + 40 711 + 4536 = 47 751 (IIIa+IV+VIa)	< 74 854 t	< 61 930 t	0.23	0.37	121 964 t	195 868 t	MSY approach
Plaice IIIa-IV	10 056 + 128 376 = 138 432 (IIIa+IV)	< 213 440 t	< 159 197 t	0.18	0.30	956 796 t	940 500 t	MP
Sole IV	11 900	< 12 835 t	< 11 921 t	0.25	0.20	50 022 t	54 033 t	MP
Saithe IIIa-IV-VI	66 006 + 6848 = 72 854 (IV+VI)	< 75 049 t	< 68 601 t	0.33	0.30	173 473 t	168 129 t	MP
Whiting IV-VIId	13 678 / 0.83 = 16 479 (Landings ratio IV-VIId)	< 25 000 t	< 13 957 t	0.23	0.16	326 331 t	354 000 t	MP
Sole VIId	3483	< 2685 t	< 2376 t	0.50	0.30	8440 t	10 036 t	MSY approach
Plaice VIId	4787 x 0.77 = 3686 (Landings ratio VIId-VIIe)	< 17 250 t	< 11 096 t	0.07	0.25	92 918 t	89 282 t	MSY approach
Turbot IV	4642 x 0.74 = 3435 (Landings ratio Turbot-Brill)*	< 1995 t	< 1925 t					Precautionary approach
Brill IV	4642 x 0.26 = 1207 (Landings ratio Turbot-Brill)*	< 1720 t**	< 1599 t**					Precautionary approach
Dab IV	18 434 x 0.71 = 13 088 (Landings ratio Dab-Flounder)*	< 66 718 t**	< 6672 t**					Precautionary approach
Flounder IV	18 434 x 0.29 = 5346 (Landings ratio Dab-Flounder)*	< 4737 t**	< 2606 t**					Precautionary approach

Species	Agreed TAC (summed TACs) – 2015	Catch – advice for 2016	Wanted catch – advice for 2016	F/Harvest ratio for 2015	F/Harvest ratio for 2016	SSB 2016	SSB 2017	Rational
Nephrops in Botney Gut (FU 5)		< 1159 t	< 1043 t					Data limited approach
Nephrops in Farn Deeps (FU 6)		< 738 t	< 680 t	17.70	5.40			MSY approach
Nephrops in Fladen Ground (FU 7)		< 8549 t	< 8539 t	3.50	7.50			MSY approach
Nephrops in Firth of Forth (FU 8)		< 1316 t	< 1203 t	29.10	16.30			MSY approach
Nephrops in Moray Firth (FU 9)		< 943 t	< 923 t	14.70	11.80			MSY approach
Nephrops in Noup (FU 10)		< 33 t	< 32 t					Data limited approach
Nephrops in Norwegian Deep (FU 32)		< 642 t	< 554 t					Precautionary approach
Nephrops in Horn's Reef (FU 33)		< 1136 t	< 1136 t					Data limited approach
Nephrops in Devil's Hole (FU 34)		< 410 t	< 383 t					Data limited approach
Nephrops in other rectangles (NEPOTH)		< 376 t	< 376 t					Data limited approach
Nephrops in Division IIIa		< 11 793 t	< 7827 t	6.00	7.90			MSY approach

***Proxy TAC based on landings split in 2014**

****based on split IIIa-IV-VIId,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		
	90-99		TR2
	80_89		
	70-79		
	16-31		TR3
Otter	>=120	Otter	TR1
	110-119		
	90-99		TR2
	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
BE_Beam<24	BT2.4	441.41	1357.23
	BT2.7D	281.27	841.57
	OTH	664.69	26.34
BE_Beam>=24	BT1.4	1457.18	5827.74
	BT2.4	1321.52	3356.25
	BT2.7D	1965.28	2036.54
BE_Otter	OTH	167.55	1052.60
	TR2.4	584.99	3196.76
BE_Static	GT1.7D	44.85	57.72
	OTH	63.46	32.60
DK_Beam	BT1.4	355.93	1434.41
	OTH	70.66	283.31
DK_FDF	OTH	15.47	74.81
	TR1.3AN	297.83	2605.87
	TR1.4	1691.25	7371.62
	TR2.4	63.77	313.16
DK_Otter<24	OTH	438.26	181.47
	TR1.3AN	304.66	1947.88
	TR1.4	309.97	2383.52
	TR2.3AN	1931.14	3476.85
	TR2.4	102.52	769.51
DK_Otter24-40	OTH	1173.60	1134.08
	TR1.4	672.23	3217.83
	TR2.4	212.59	1560.88
DK_Seine	TR1.3AN	319.28	4234.85
	TR1.4	551.83	3631.57
DK_Static	GN1.3AN	290.73	912.57
	GN1.4	1416.05	5768.72
	OTH	58.77	195.07
EN_Beam	BT1.4	1576.60	6707.23
	BT2.4	1548.14	4959.73
	BT2.7D	185.71	372.96
	OTH	2.21	3.68
EN_FDF	OTH	0.54	26.59
	TR1.4	1342.56	11370.27
EN_Otter<24	OTH	156.54	79.78
	TR1.4	112.84	500.77
	TR2.4	936.59	2155.58
EN_Otter>=40	OTH	72.08	225.62
	TR1.4	586.46	1797.80
EN_Otter24-40	OTH	173.52	481.66
	TR1.4	301.30	2282.54
EN_U10	GN1.7D	732.40	729.22
	GT1.7D	353.34	410.84
	OTH	3357.10	841.16
	TR2.4	553.11	1667.86
	TR2.7D	121.51	158.28
FR_Beam	BT2.7D	247.89	305.40
	OTH	28.91	108.70
FR_Nets	GT1.4	801.56	956.82
	GT1.7D	2691.92	2812.15
	OTH	103.83	105.27
FR_Otter>=40	OTH	1147.08	17.59
	TR1.4	5099.72	8459.59
FR_Otter10-40	OTH	1315.32	108.81
	TR2.4	1436.60	4128.15
	TR2.7D	8418.56	7512.97
FR_U10m	OTH	104.88	26.00
	TR2.7D	144.05	231.08
GE_Beam>=24	BT2.4	959.86	2442.17
	OTH	61.57	284.68
GE_FDF	OTH	21.78	169.03
	TR1.4	433.85	4352.92
GE_Otter<24	OTH	15.81	96.34
	TR1.4	128.21	1736.16
	TR2.4	124.17	3047.13
GE_Otter>=40	OTH	5.85	45.83
	TR1.4	458.51	4146.21
GE_Otter24-40	OTH	38.09	141.48
	TR1.4	394.27	2861.54
	TR2.4	109.82	1319.03
NL_Beam<24	BT2.4	230.25	1621.27
	OTH	4.17	46.97
NL_Beam>=40	BT1.3AN	162.81	1141.35
	BT1.4	800.68	3732.71
	BT2.4	15771.64	44623.00
	OTH	2288.70	65.53
NL_Beam24-40	BT2.4	9.71	6977.26
NL_Otter	OTH	89.97	5.64
	TR1.3AN	1004.01	960.97
	TR1.4	1286.98	6544.98
	TR2.4	927.29	9902.53
	TR2.7D	2032.64	1138.87
NO_Otter<40	OTH	1959.41	958.94
	TR1.4	5155.91	11425.94
NO_Otter>=40	TR1.4	681.67	28718.40
NO_Static	GN1.4	671.28	4384.89
	LL1.4	4.82	2124.28
	OTH	50379.59	199.00
OTH_OTH	OTH	3.17	12143.20
SC_FDF	OTH	1956.76	14.98
	TR1.4	0.93	17230.89
SC_Otter<24	OTH	3901.88	2.89
	TR1.4	3183.89	18445.99
	TR2.4	4281.56	11689.65
SC_Otter>=24	TR1.4	148.94	28090.73
	TR2.4	678.24	570.31
SC_Static	OTH	4244.73	148.98
	pots.4	2.24	35.18
SC_U10_OTB	OTH	447.40	6.53
	TR2.4	3609.65	727.86
SW_Otter	OTH	236.05	2365.17
	TR1.4	9777.00	1502.24

Table 2.4.2.b Proportion of the stocks total landings and discards (from WGNSSK) covered by the MIXFISH fleets. A ratio > 1 means that the catch information in MIXFISH is higher than the information used by WGNSSK.

YEAR	STOCK	WG.LAND	WG.DISC	MIX.LAND	MIX.DISC	DIFF.LAND	RATIO.LAND	RATIO.DISC
2013	COD-NS	30474	10291	32400	10225	1926.1	1.06	0.99
2014	COD-NS	34653	10617	35063	9718	410.6	1.01	0.92
2013	HAD	43712	3300	39425	2215	-4287.3	0.9	0.67
2014	HAD	41165	5087	37141	4655	-4023.6	0.9	0.92
2013	NEP10	15	1	15	1	-0.2	0.99	0.98
2014	NEP10	16	1	16	1	-0.4	0.97	0.99
2013	NEP32	191	45	132	9	-58.5	0.69	0.19
2014	NEP32	206	5	158	4	-48.2	0.77	0.76
2013	NEP33	946	242	884	274	-62.1	0.93	1.13
2014	NEP33	1146	299	1156	302	10.0	1.01	1.01
2013	NEP34	121	8	113	8	-8.5	0.93	0.92
2014	NEP34	293	20	293	20	0.1	1	1.01
2013	NEP5	1050	117	1187	131	137.1	1.13	1.12
2014	NEP5	1123	124	1123	124	0.3	1	1
2013	NEP6	2982	450	2943	447	-39.1	0.99	0.99
2014	NEP6	2503	198	2437	193	-65.8	0.97	0.97
2013	NEP7	2951	0	2961	0	9.6	1	
2014	NEP7	4146	37	4149	34	2.6	1	0.92
2013	NEP8	1501	301	1502	286	0.8	1	0.95
2014	NEP8	2370	353	2379	344	9.4	1	0.98
2013	NEP9	655	10	655	10	0.3	1	0.96
2014	NEP9	1234	87	1284	86	50.4	1.04	0.99
2013	NEPOTH-NS	409	NA	586	18	177.2	1.43	
2014	NEPOTH-NS	514	22	356	14	-157.6	0.69	0.63
2013	PLE-EC	3926	2819	4183	2677	256.9	1.07	0.95
2014	PLE-EC	3931	3181	3133	2821	-797.7	0.8	0.89

YEAR	STOCK	WG.LAND	WG.DISC	MIX.LAND	MIX.DISC	DIFF.LAND	RATIO.LAND	RATIO.DISC
2013	PLE-NS	86222	40025	91914	36993	5691.7	1.07	0.92
2014	PLE-NS	80686	52937	80024	48828	-662.3	0.99	0.92
2013	POK	79684	0	71874	8091	-7810.5	0.9	
2014	POK	75176	0	68601	3870	-6575.9	0.91	
2013	SOL-EC	4266	0	5310	115	1044.2	1.24	
2014	SOL-EC	4350	0	4637	743	286.8	1.07	
2013	SOL-NS	16232	1458	13829	280	-2402.7	0.85	0.19
2014	SOL-NS	11960	798	12542	1484	581.8	1.05	1.86
2013	TUR	2982	0	3206	308	224.4	1.08	
2014	TUR	2834	0	2865	162	30.6	1.01	
2013	WHG-NS	19335	5976	18966	6096	-368.8	0.98	1.02
2014	WHG-NS	18746	10451	18638	10647	-108.2	0.99	1.02

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

		COD–NS	HAD	PLE–EC	PLE–NS	POK	SOL–EC	SOL–NS	WHG–NS
2015	Fbar	0.393	0.233	0.072	0.18	0.325	0.502	0.252	0.23
	FmultVsF14	1	0.961	0.641	1	1.053	0.918	0.988	1
	landings	41456	32270	3196	99264	72854	3483	11900	21670
	ssb	149326	144333	81530	901694	199270	8143	41137	262948
2016	Fbar	0.33	0.37	0.25	0.293	0.298	0.3	0.2	0.15
	FmultVsF14	0.839	1.527	2.225	1.626	0.968	0.549	0.784	0.651
	catches	48271	75683	17648	220074	68600	2376	12834	24850
	ssb	158954	121740	94149	969835	173473	8439	50015	326018
2017	ssb	176427	195109	90775	954750	168129	10035	54027	353735

		NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEP34	NEPOTH
2015	Fbar	-					-	-	-	-	-
	FmultVsF14	-					-	-	-	-	-
	landings										
2016	Fbar	-	0.054	0.075	0.163	0.118	-	-	-	-	-
	FmultVsF14	-	0.415	2.143	0.56	0.803	-	-	-	-	-
	landings	1159	741	8063	1366	964	33	642	1418	410	409

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	POK	SOL–EC	SOL–NS	WHG–NS
2015	Landings								
	Baseline	41456	32270	3196	99264	72854	3483	11900	21670
	ICES	42394	32581	3193	99252	72854	3483	11893	21731
	% difference	-2.21%	-0.95%	0.09%	0.01%	0.00%	0.00%	0.06%	-0.28%
2016	Catches								
	Baseline	48271	75683	17648	220074	68600	2376	12834	24850
	ICES	49259	74854	17250	213440	75049	2685	12835	25000
	% difference	-2.01%	1.11%	2.31%	3.11%	-8.59%	-11.51%	-0.01%	-0.60%

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.

		NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEP34	NEPOTH
2016	Catch										
	Baseline	1159	741	8063	1366	964	33	642	1418	410	409
	ICES	1159	738	8549	1316	943	33	642	1136*	410	376*
	% difference	0.00%	0.41%	-5.68%	3.80%	2.23%	0.00%	0.00%	24.82%	0.00%	8.78%

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

Table 2.5.2.2.a Results of Final Fcube runs.

	Year	scenario	COD-NS	HAD	PLE-NS	PLE-EC	POK	SOL-NS	SOL-EC	WHG-NS	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEP34	NEPOTH-NS	NEP-TOT
Landings	2015	baseline	41456.00	32270.00	99264.00	3196.00	72854.00	11900.00	3483.00	21670.00											
Fbar	2015	baseline	0.39	0.23	0.18	0.07	0.33	0.25	0.50	0.23	-					-	-	-	-	-	-
Fbar	2016	baseline	0.33	0.37	0.29	0.25	0.30	0.20	0.30	0.15	-	0.05	0.08	0.16	0.12	-	-	-	-	-	-
FmultVsF14	2015	baseline	1.00	0.96	1.00	0.64	1.05	0.99	0.92	1.00	-					-	-	-	-	-	-
FmultVsF14	2015	sq_E	1.08	1.07	1.14	0.99	1.00	1.07	1.01	0.87	-	1.19	1.00	1.21	1.09	-	-	-	-	-	-
FmultVsF14	2016	baseline	0.84	1.53	1.63	2.23	0.97	0.78	0.55	0.65	-	0.42	2.14	0.56	0.80	-	-	-	-	-	-
FmultVsF14	2016	cod-ns	0.84	0.82	0.87	0.71	0.85	1.05	0.88	0.70	-	1.00	0.65	0.86	0.75	-	-	-	-	-	-
FmultVsF14	2016	Ef_Mgt	0.82	0.78	0.88	0.91	0.89	1.04	0.98	0.76	-	1.05	0.74	1.08	0.89	-	-	-	-	-	-
FmultVsF14	2016	max	2.22	2.26	1.99	2.22	2.29	1.84	2.51	1.99	-	3.32	2.19	3.12	2.59	-	-	-	-	-	-
FmultVsF14	2016	min	0.49	0.44	0.37	0.47	0.62	0.26	0.49	0.42	-	0.55	0.40	0.57	0.47	-	-	-	-	-	-
FmultVsF14	2016	sq_E	1.00	1.00	0.98	1.00	1.00	1.05	1.01	0.95	-	1.40	1.02	1.48	1.23	-	-	-	-	-	-
FmultVsF14	2016	val	1.19	1.19	1.18	0.85	1.11	1.07	1.02	0.93	-	1.29	1.11	1.42	1.26	-	-	-	-	-	-
Fbar	2015	sq_E	0.43	0.26	0.21	0.11	0.31	0.27	0.55	0.20	-	0.15	0.04	0.35	0.16	-	-	-	-	-	-
Fbar	2016	cod-ns	0.33	0.20	0.16	0.08	0.26	0.27	0.48	0.16	-	0.13	0.02	0.25	0.11	-	-	-	-	-	-
Fbar	2016	Ef_Mgt	0.32	0.19	0.16	0.10	0.28	0.27	0.53	0.17	-	0.14	0.03	0.31	0.13	-	-	-	-	-	-
Fbar	2016	max	0.87	0.55	0.36	0.25	0.71	0.47	1.37	0.46	-	0.43	0.08	0.91	0.38	-	-	-	-	-	-
Fbar	2016	min	0.19	0.11	0.07	0.05	0.19	0.07	0.27	0.10	-	0.07	0.01	0.16	0.07	-	-	-	-	-	-
Fbar	2016	sq_E	0.39	0.24	0.18	0.11	0.31	0.27	0.55	0.22	-	0.18	0.04	0.43	0.18	-	-	-	-	-	-
Fbar	2016	val	0.47	0.29	0.21	0.10	0.34	0.27	0.56	0.21	-	0.17	0.04	0.41	0.19	-	-	-	-	-	-
Landings	2015	baseline	41456.00	32270.00	99264.00	3196.00	72854.00	11900.00	3483.00	21670.00											0.00
Landings	2015	sq_E	44325.00	35373.00	111789.00	4872.00	69753.00	12719.00	3751.00	19096.00		1883.00	3976.00	2367.00	1215.00						9442.00
Landings	2016	baseline	48271.00	75683.00	220074.00	17648.00	68600.00	12834.00	2376.00	24850.00	1159.00	741.00	8063.00	1366.00	964.00	33.00	642.00	1418.00	410.00	409.00	15205.00
Landings	2016	cod-ns	47128.00	42903.00	121400.00	5853.00	62243.00	16325.00	3413.00	27156.00	696.00	1590.00	2573.00	1689.00	837.00	20.00	386.00	852.00	246.00	246.00	9136.00
Landings	2016	Ef_Mgt	46069.00	40751.00	122943.00	7501.00	64889.00	16192.00	3696.00	29008.00	801.00	1659.00	2931.00	2110.00	994.00	23.00	444.00	980.00	283.00	283.00	10507.00
Landings	2016	max	101154.00	102907.00	0	0	136251.00	25594.00	6888.00	70557.00	2390.00	5256.00	8690.00	6117.00	2896.00	68.00	1324.00	2924.00	846.00	843.00	31356.00
Landings	2016	min	29047.00	23760.00	53796.00	3958.00	47078.00	4525.00	2086.00	16345.00	426.00	865.00	1590.00	1108.00	528.00	12.00	236.00	521.00	151.00	150.00	5587.00
Landings	2016	sq_E	54726.00	51330.00	135452.00	8170.00	71446.00	16264.00	3792.00	36084.00	1097.00	2213.00	4053.00	2898.00	1370.00	31.00	607.00	1342.00	388.00	387.00	14385.00
Landings	2016	val	63388.00	60086.00	161206.00	6971.00	77836.00	16508.00	3821.00	35168.00	1110.00	2040.00	4424.00	2783.00	1411.00	32.00	615.00	1358.00	393.00	392.00	14556.00
Ld_Mgt-Plan	2016	sq_E	47128.00	74566.00	219623.00	17067.00	69489.00	12636.00	2298.00	25204.00	1159.00	741.00	8063.00	1366.00	964.00	33.00	642.00	1418.00	410.00	409.00	15205.00
Catches	2015	sq_E	57453.00	44102.00	162234.00	7661.00	69753.00	13650.00		31967.00											

	201							16325.0				1590.0	2573.0	1689.0							
Catches	6	cod-ns	47128.00	42903.00	121400.00	5853.00	62243.00	0	3413.00	27156.00	696.00	0	0	0	837.00	20.00	386.00	852.00	246.00	246.00	9136.00
	201							16192.0				1659.0	2931.0	2110.0							
Catches	6	Ef_Mgt	46069.00	40751.00	122943.00	7501.00	64889.00	0	3696.00	29008.00	801.00	0	0	0	994.00	23.00	444.00	980.00	283.00	283.00	10507.00
	201		101154.0	102907.0			136251.0	25594.0			2390.0	5256.0	8690.0	6117.0	2896.0		1324.0	2924.0			
Catches	6	max	0	0	256904.00	17067.00	0	0	6888.00	70557.00	0	0	0	0	0	68.00	0	0	846.00	843.00	31356.00
	201												1590.0	1108.0							
Catches	6	min	29047.00	23760.00	53796.00	3958.00	47078.00	4525.00	2086.00	16345.00	426.00	865.00	0	0	528.00	12.00	236.00	521.00	151.00	150.00	5587.00
	201							16264.0			1097.0	2213.0	4053.0	2898.0	1370.0			1342.0			
Catches	6	sq_E	54726.00	51330.00	135452.00	8170.00	71446.00	0	3792.00	36084.00	0	0	0	0	0	31.00	607.00	0	388.00	387.00	14385.00
	201							16508.0			1110.0	2040.0	4424.0	2783.0	1411.0			1358.0			
Catches	6	val	63388.00	60086.00	161206.00	6971.00	77836.00	0	3821.00	35168.00	0	0	0	0	0	32.00	615.00	0	393.00	392.00	14556.00
	201	base-	158954.0	121740.0			173473.0	50015.0		326018.0											
ssb	6	line	0	0	969835.00	94149.00	0	0	8439.00	0	-	-	-	-	-	-	-	-	-	-	-
	201	base-	176427.0	195109.0			168129.0	54027.0	10035.0	353735.0											
ssb	7	line	0	0	954750.00	90775.00	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
	201		155097.0	118447.0			176526.0	49153.0		329574.0											
ssb	6	sq_E	0	0	951703.00	90847.00	0	0	8155.00	0	-	-	-	-	-	-	-	-	-	-	-
	201		172550.0	224129.0	1031386.0	102150.0	177186.0	49572.0		354113.0											
ssb	7	cod-ns	0	0	0	0	0	0	8634.00	0	-	-	-	-	-	-	-	-	-	-	-
	201		173736.0	226307.0	1029829.0	100050.0	174777.0	49707.0		352604.0											
ssb	7	Ef_Mgt	0	0	0	0	0	0	8333.00	0	-	-	-	-	-	-	-	-	-	-	-
	201		114022.0	164911.0			111205.0	40187.0		319226.0											
ssb	7	max	0	0	895080.00	88039.00	0	0	4969.00	0	-	-	-	-	-	-	-	-	-	-	-
	201		192961.0	243610.0	1099694.0	104574.0	191047.0	61602.0	10046.0	362955.0											
ssb	7	min	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
	201		164079.0	215637.0	1017210.0		168821.0	49633.0		346854.0											
ssb	7	sq_E	0	0	0	99200.00	0	0	8231.00	0	-	-	-	-	-	-	-	-	-	-	-
	201		154506.0	206868.0		100724.0	163035.0	49385.0		347598.0											
ssb	7	val	0	0	991254.00	0	0	0	8200.00	0	-	-	-	-	-	-	-	-	-	-	-
ssb_Mgt-	201		155097.0	118447.0			176526.0	49153.0		329574.0											
Plan	6	cod-ns	0	0	951703.00	90847.00	0	0	8155.00	0	-	-	-	-	-	-	-	-	-	-	-

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

	SINGLE–STOCK CATCH	CATCH PER MIXED–FISHERIES SCENARIO 2016					
Stock	advice 2016*	"Max"	"Min"	"Cod"	"Sq_E"	"Val"	"Ef_Mgt"
Cod IIIaN, IV, VIId	49.259	2.05	0.59	0.96	1.11	1.29	0.94
Haddock IIIaN, IV, VIa	74.854	1.37	0.32	0.57	0.69	0.80	0.54
Plaice VIId	17.250	0.99	0.23	0.34	0.47	0.40	0.43
Plaice IV	213.440	1.20	0.25	0.57	0.63	0.76	0.58
Saithe IIIaN, IV, VI	75.049	1.82	0.63	0.83	0.95	1.04	0.86
Sole VIId	2.685	2.57	0.78	1.27	1.41	1.42	1.38
Sole IV	12.835	1.99	0.35	1.27	1.27	1.29	1.26
Whiting IV, VIId	25.000	2.82	0.65	1.09	1.44	1.41	1.16
Nephrops FU 5	1.159	2.06	0.37	0.60	0.95	0.96	0.69
Nephrops FU 6	0.738	7.12	1.17	2.15	3.00	2.76	2.25
Nephrops FU 7	8.549	1.02	0.19	0.30	0.47	0.52	0.34
Nephrops FU 8	1.136	4.65	0.84	1.28	2.20	2.11	1.60
Nephrops FU 9	0.943	3.07	0.56	0.89	1.45	1.50	1.05
Nephrops FU 10	0.033	2.06	0.37	0.60	0.95	0.96	0.69
Nephrops FU 32	0.642	2.06	0.37	0.60	0.95	0.96	0.69
Nephrops FU 33	1.132**	2.57	0.46	0.75	1.18	1.20	0.86
Nephrops FU 34	0.410	2.06	0.37	0.60	0.95	0.96	0.69
Nephrops other IV	0.376**	2.24	0.40	0.65	1.03	1.04	0.75

*** Advised catches no more than the indicated value.**

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

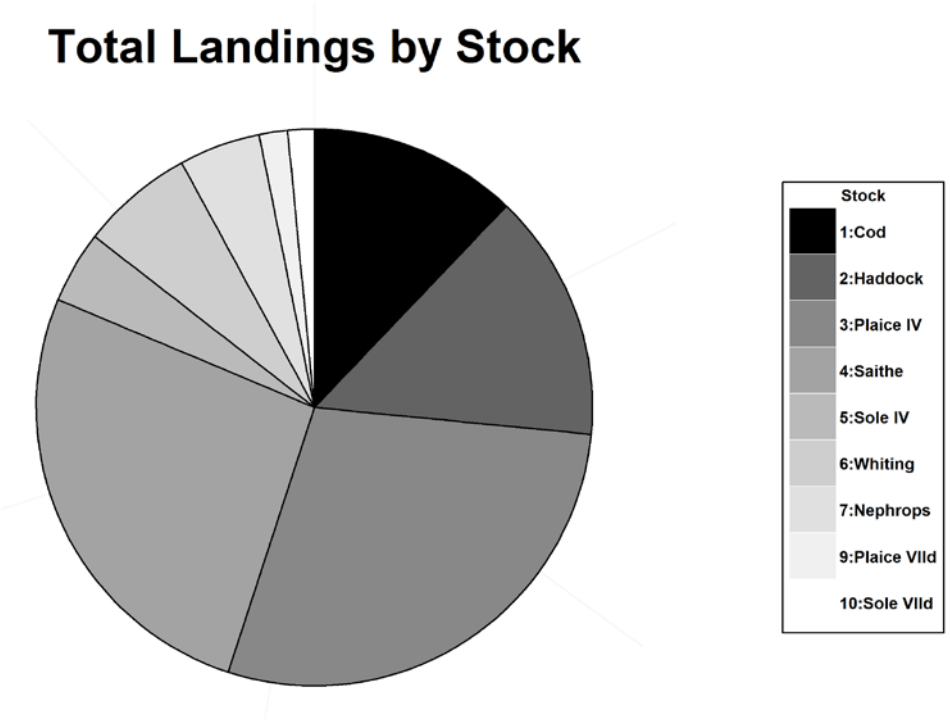


Figure 2.4.1. Distribution of landings of those stocks included in the mixed fisheries projections.

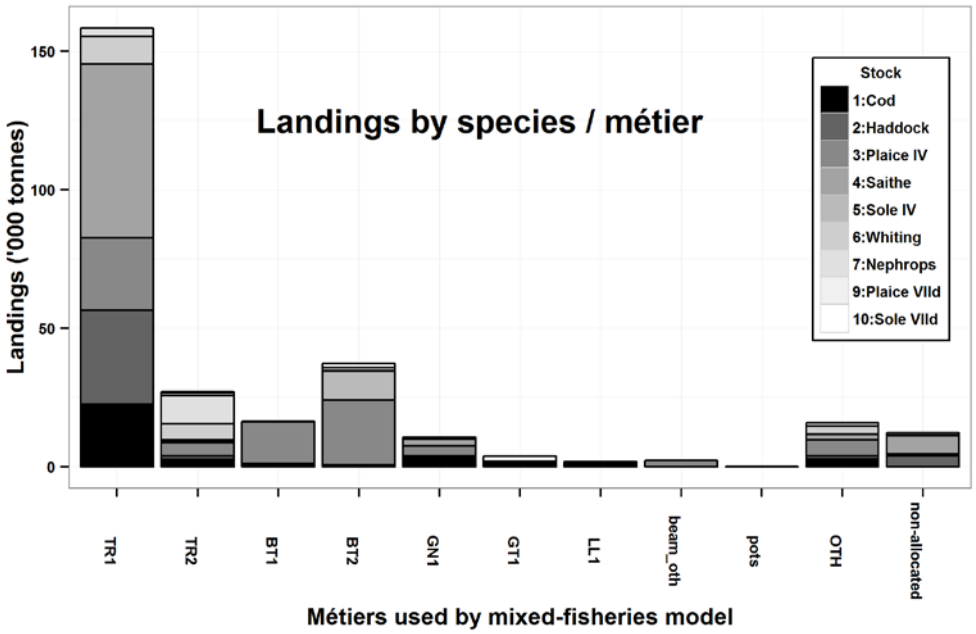


Figure 2.4.2.a. Landings distribution of species by métier with landings consisting of ≥ 1% of any of the stocks 1–10 in 2014 Note: The "other" (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and métier with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

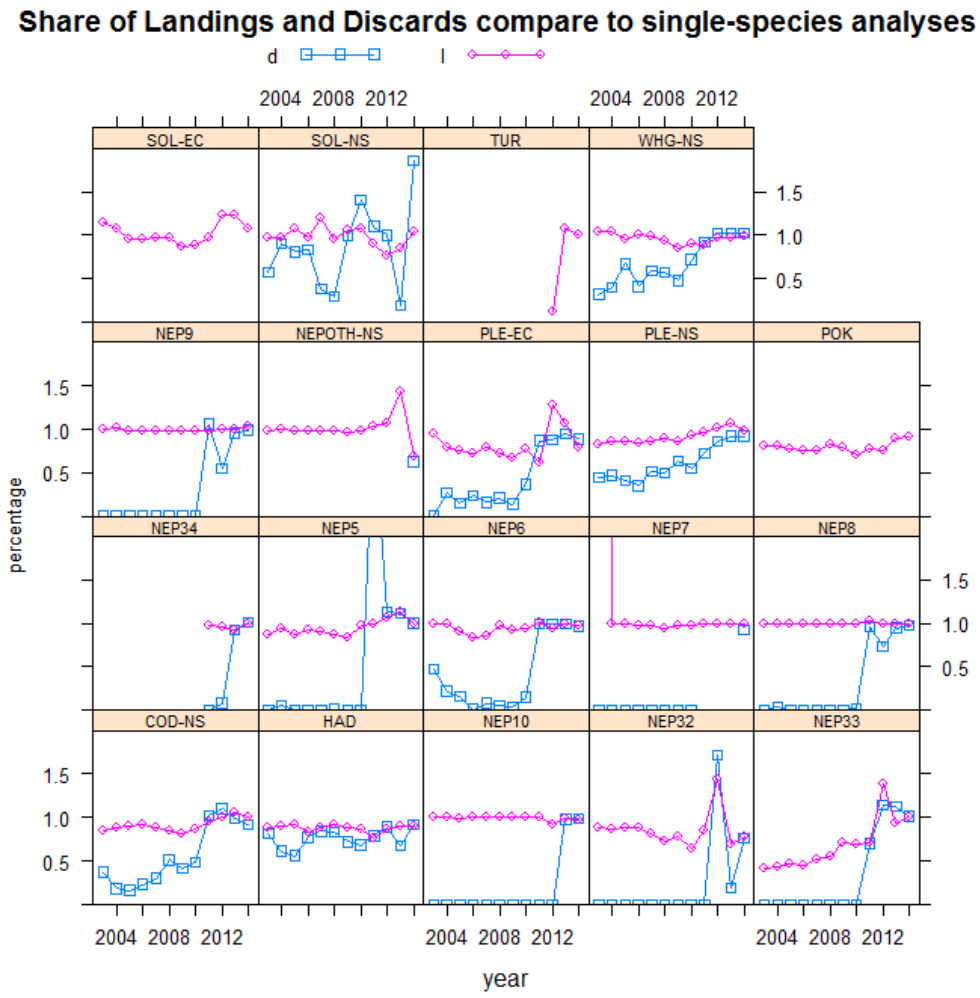


Figure 2.4.2.c. Ratio between the sum of landings and discards across fleets used in the MIXFISH analysis and the landings and discards estimated by the WGNSSK stock assessments.

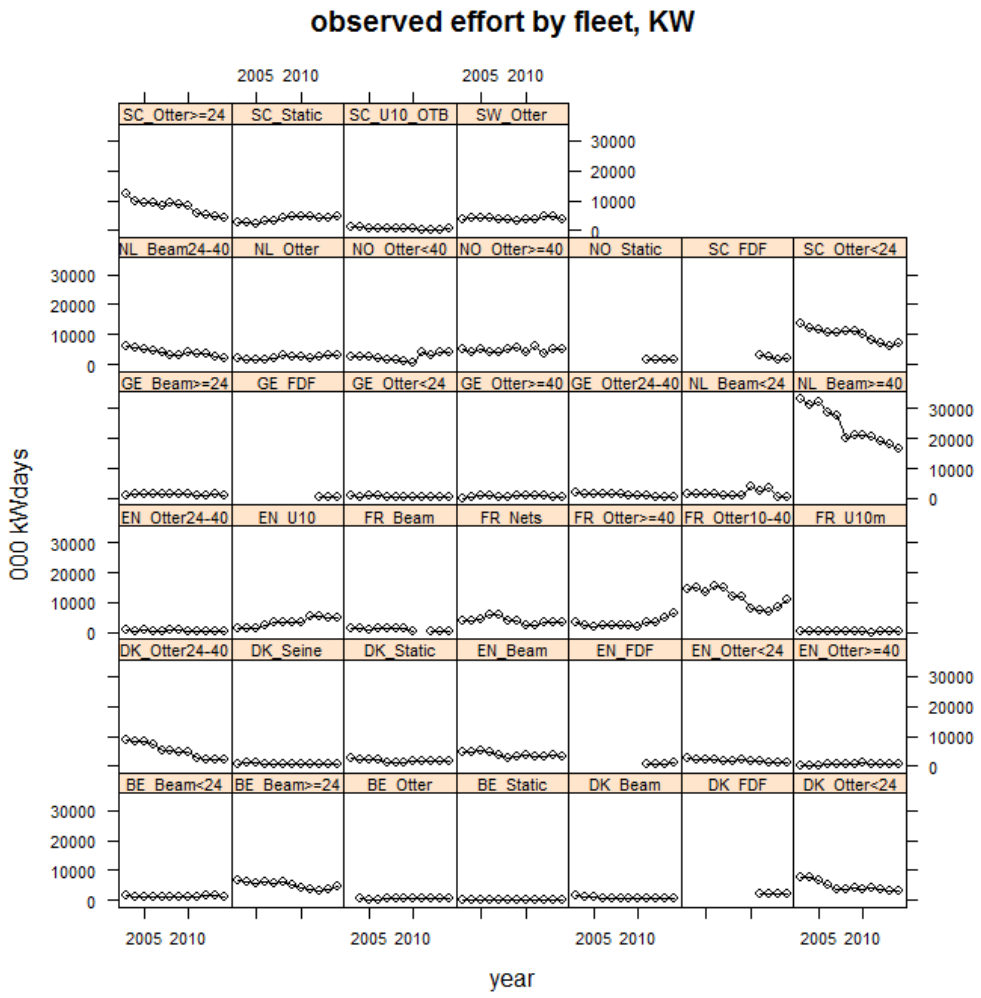


Figure 2.4.3.a. Effort by fleet and year for the North Sea demersal fleets, in '000 KWdays. Data for French fleets in 2009 were not available.

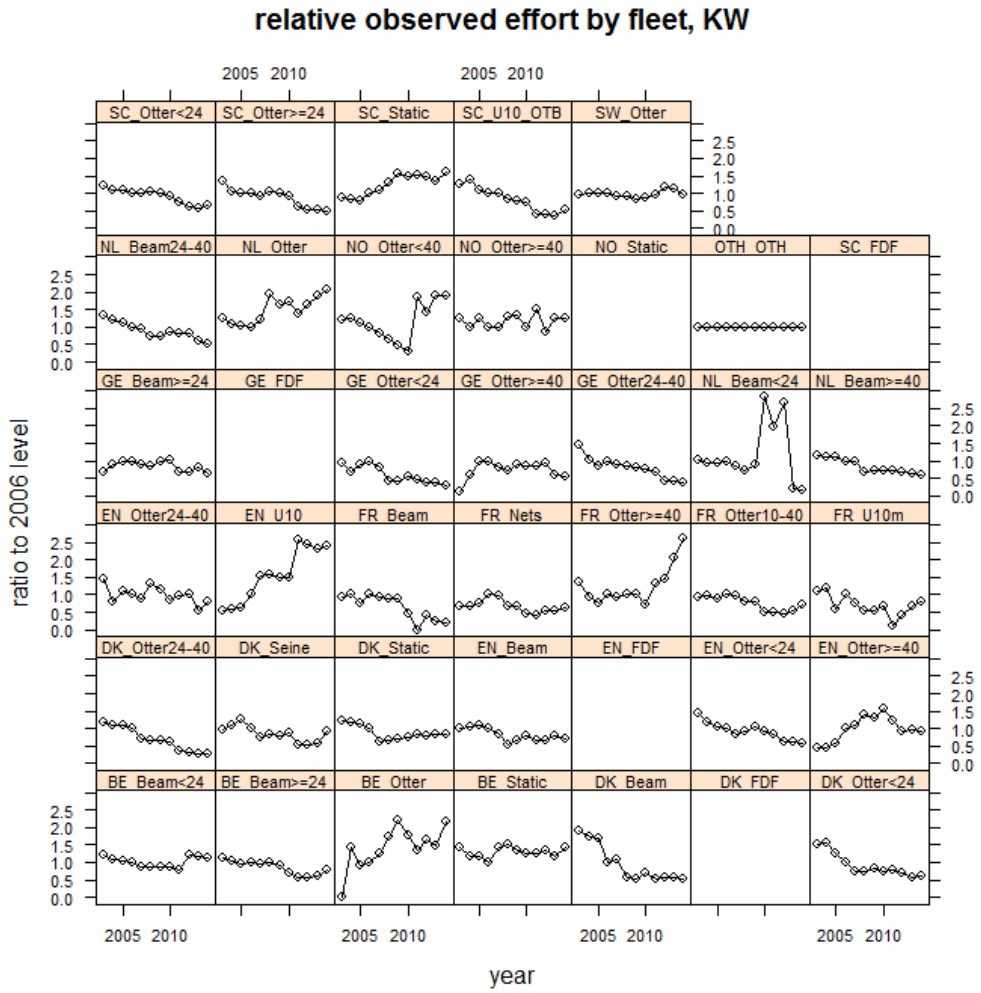


Figure 2.4.3.b. Relative trends (compared to the 2006 value) in effort (KW Days) by fleet and year for the North Sea demersal fleets. Data for French fleets in 2009 were not available.

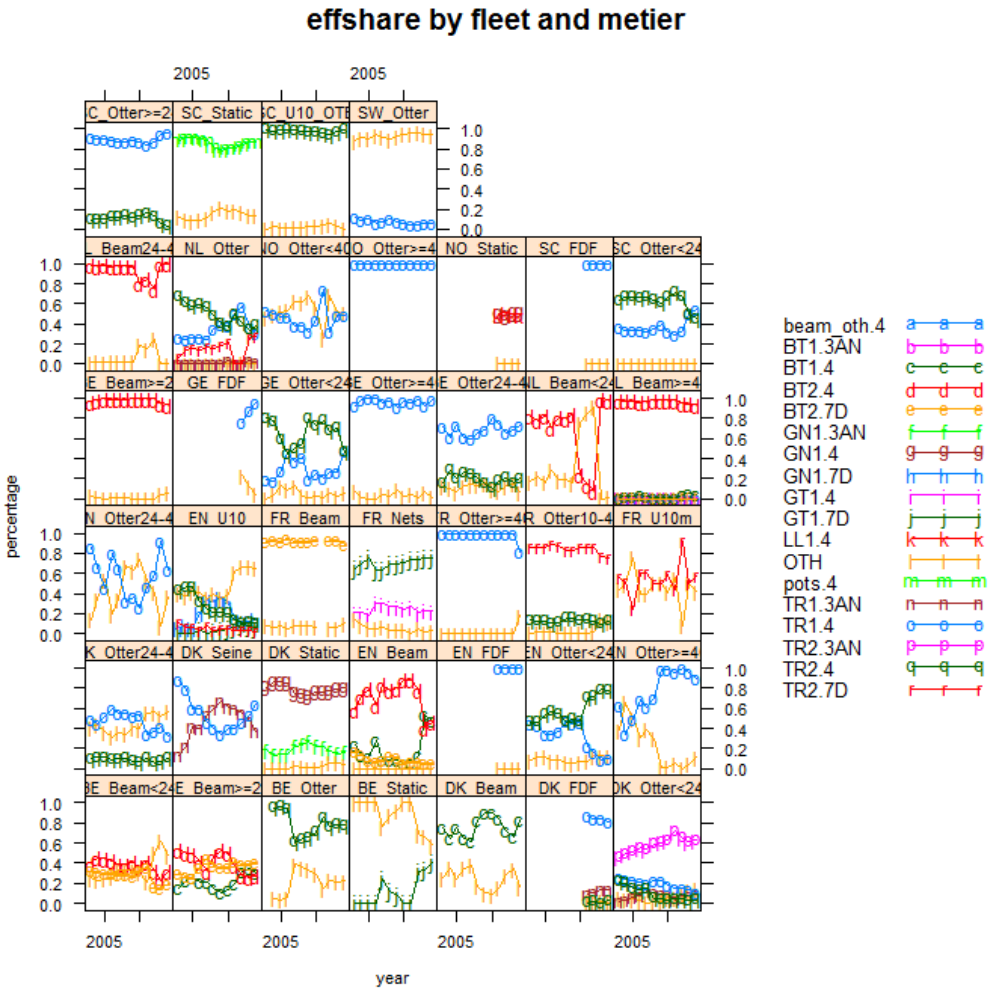


Figure 2.4.3.c. Effort share (in proportion) by métier for each fleet.

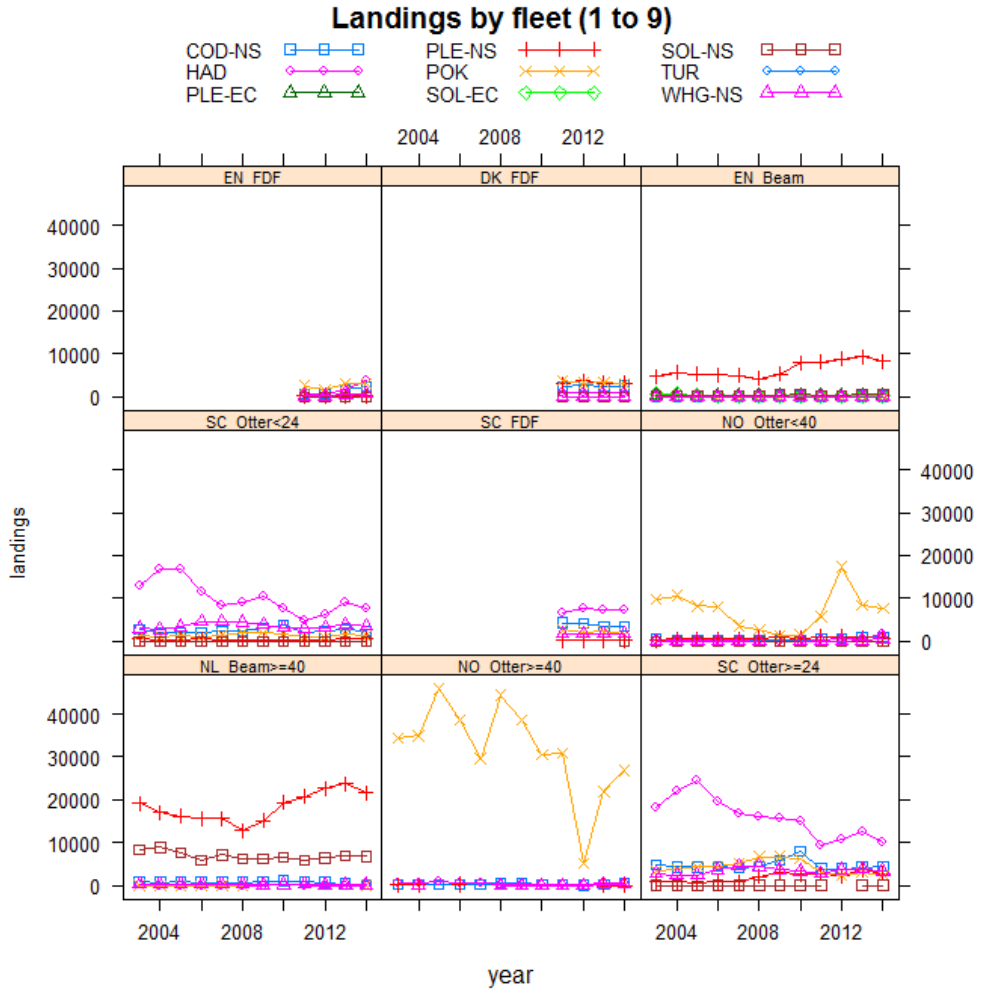


Figure 2.4.3.d. Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

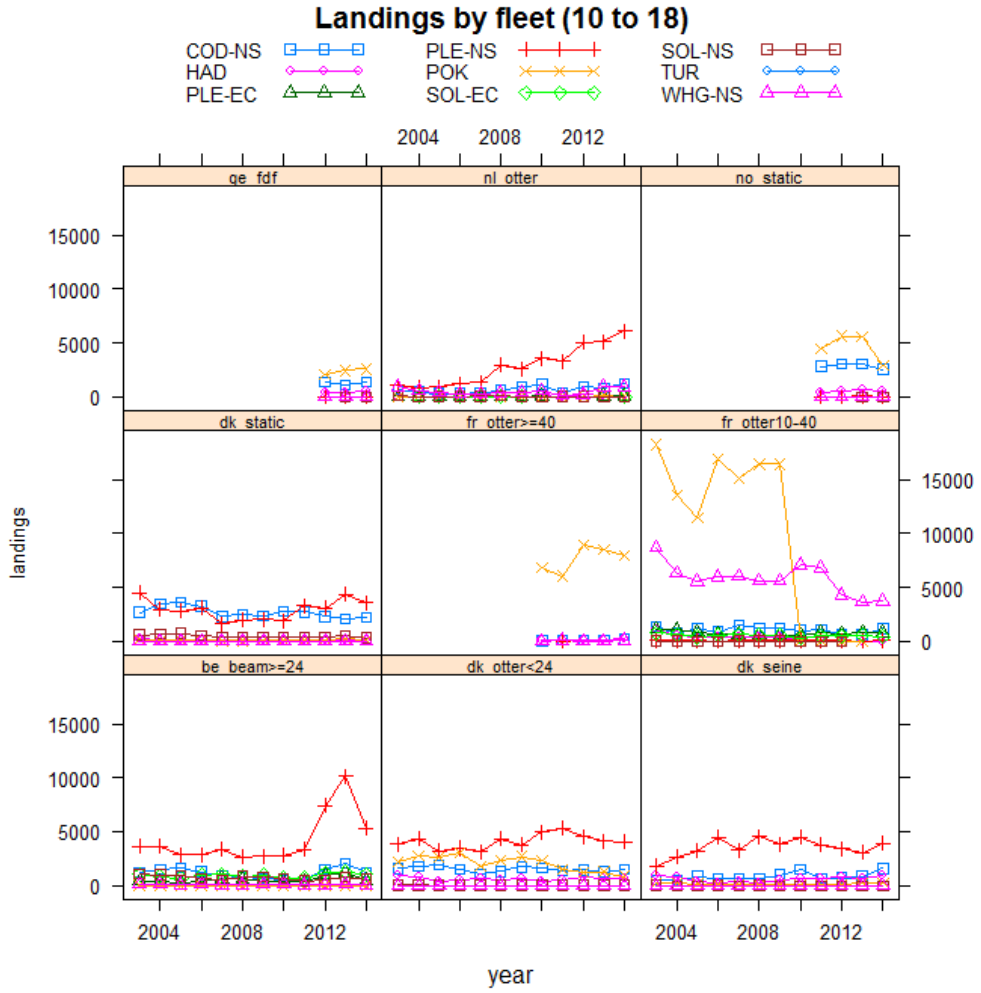


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

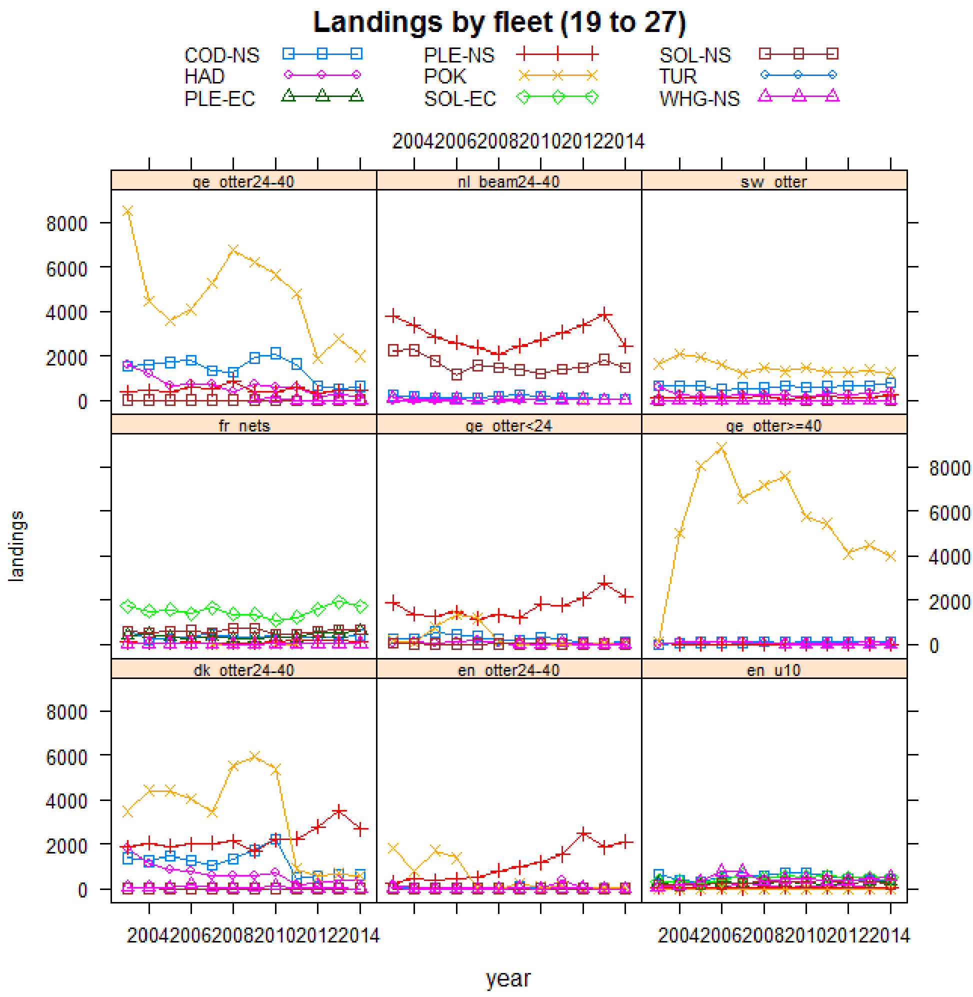


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

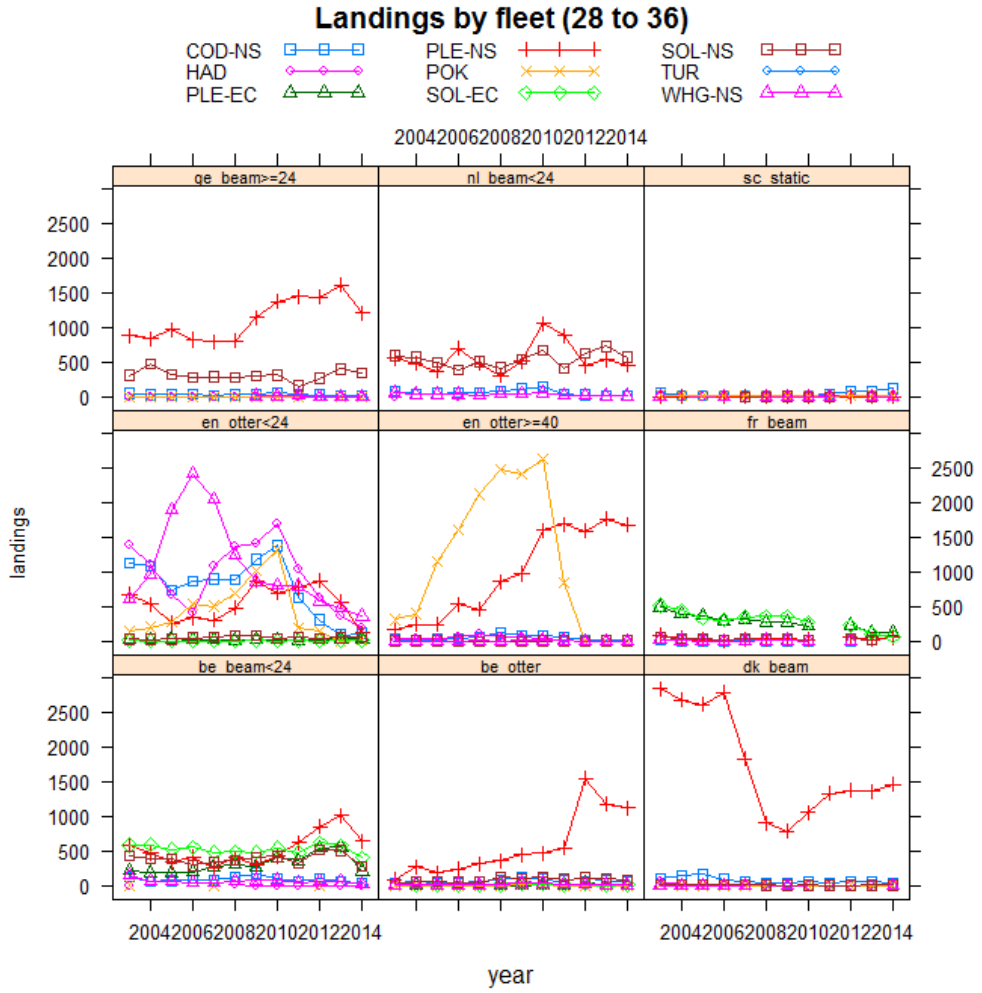


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

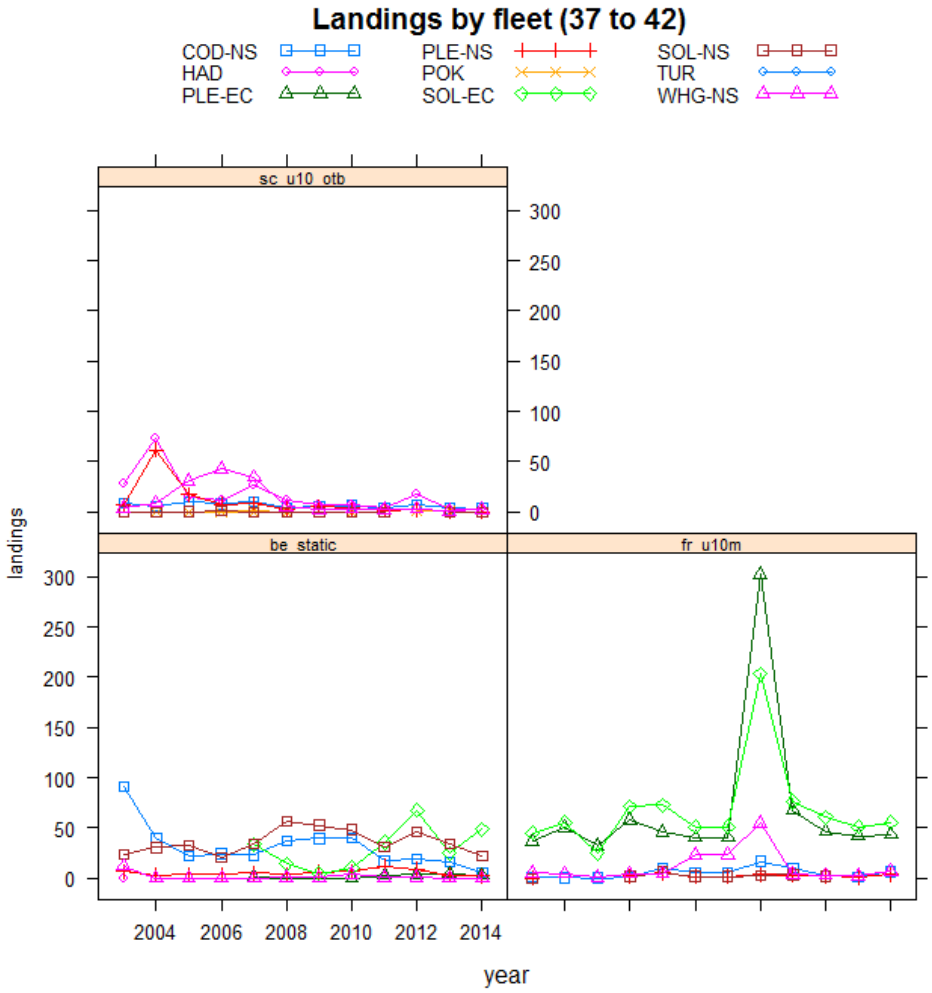


Figure 2.4.3.d (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

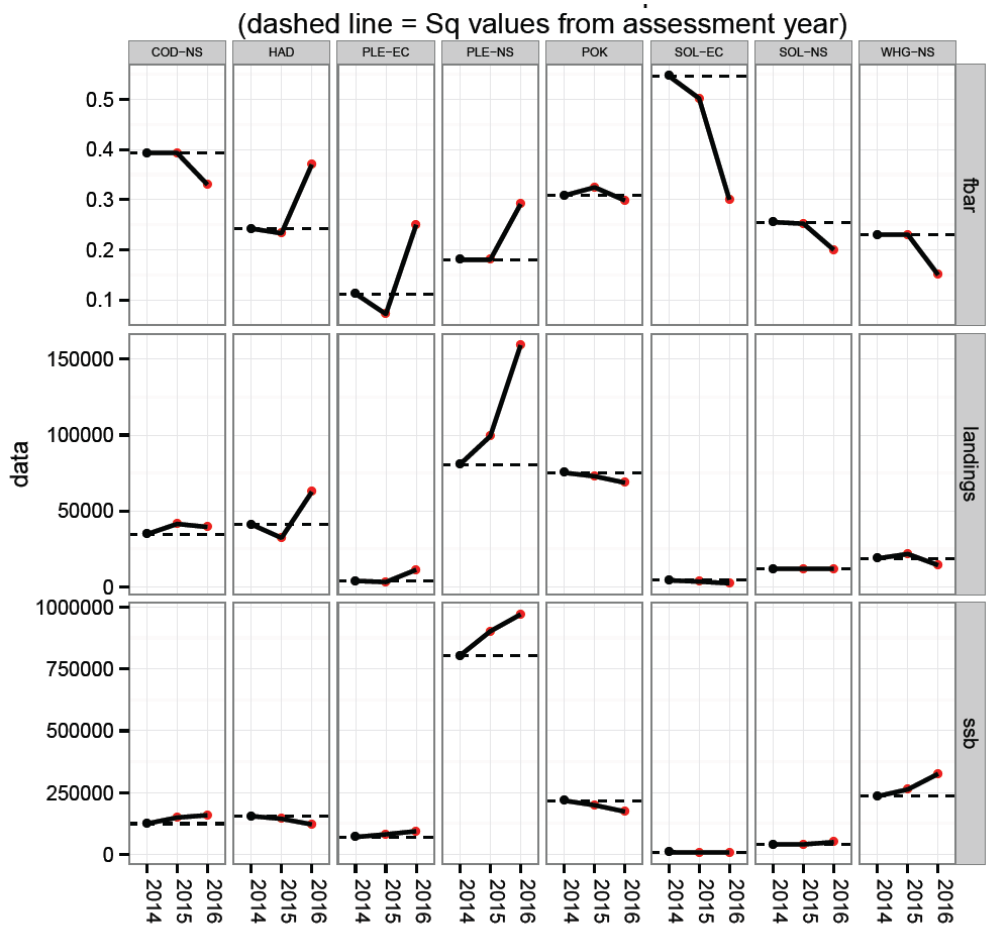


Figure 2.5.2.1.a Summary of the relative changes in the single-stock advice for 2016 compared to the situation in 2014.

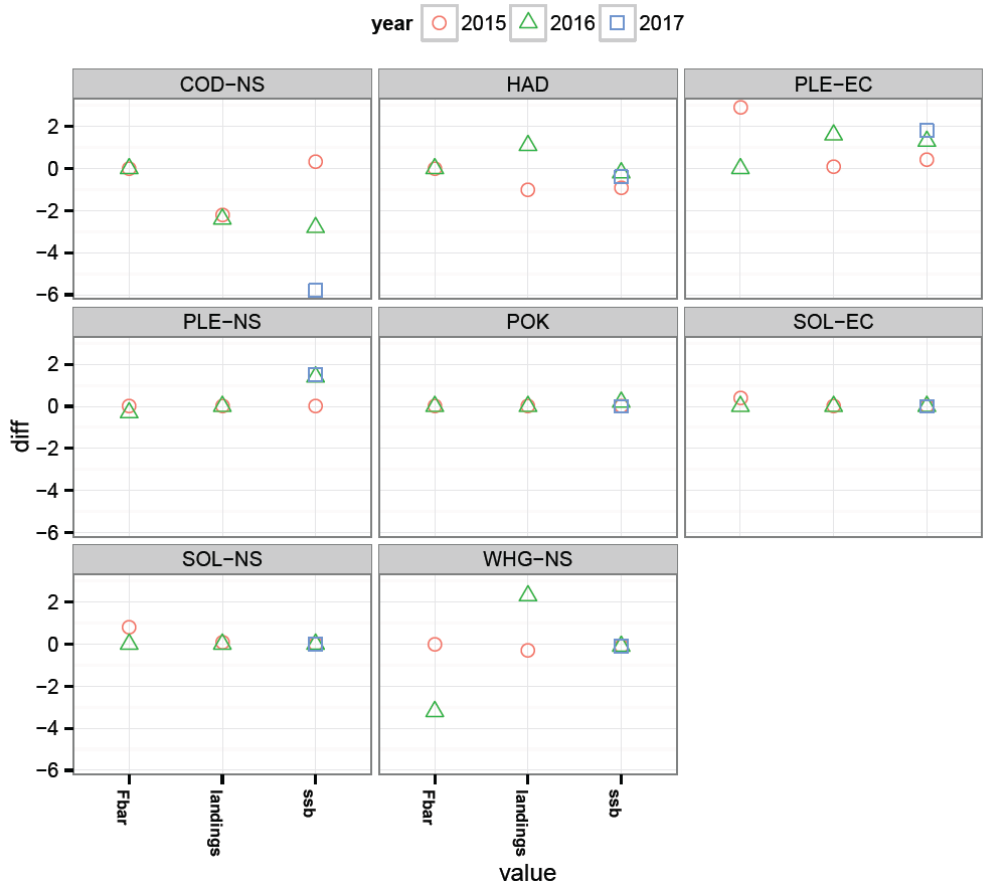


Figure 2.5.2.1.b Difference between Fcube baseline run and Single Species advice for finfish stocks, showing Fbar (2015—2016), landings (2015—2016) and SSB (2016—2017).

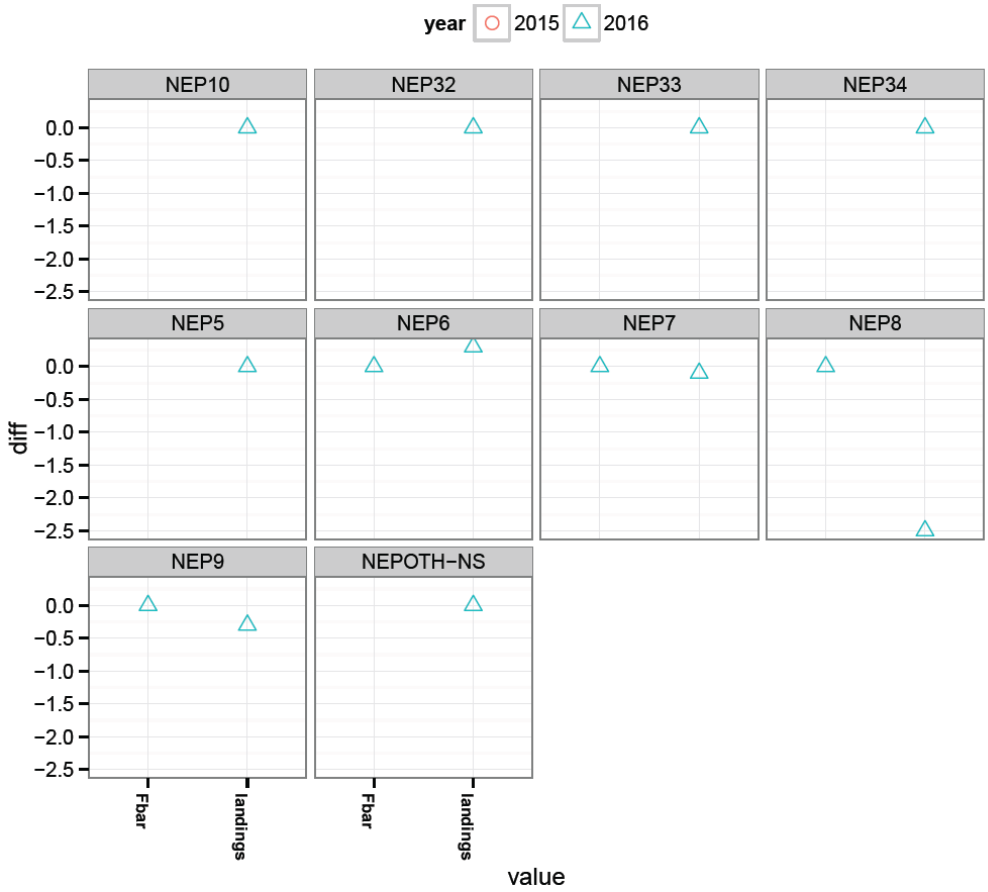


Figure 5.2.1.2b Difference between FCube baseline run and single species advice for *Nephrops* stocks. FBar and landings in 2016 only shown as harvest in intermediate year is not directly comparable. Fbar not shown for some stocks as they're non-analytical assessments.

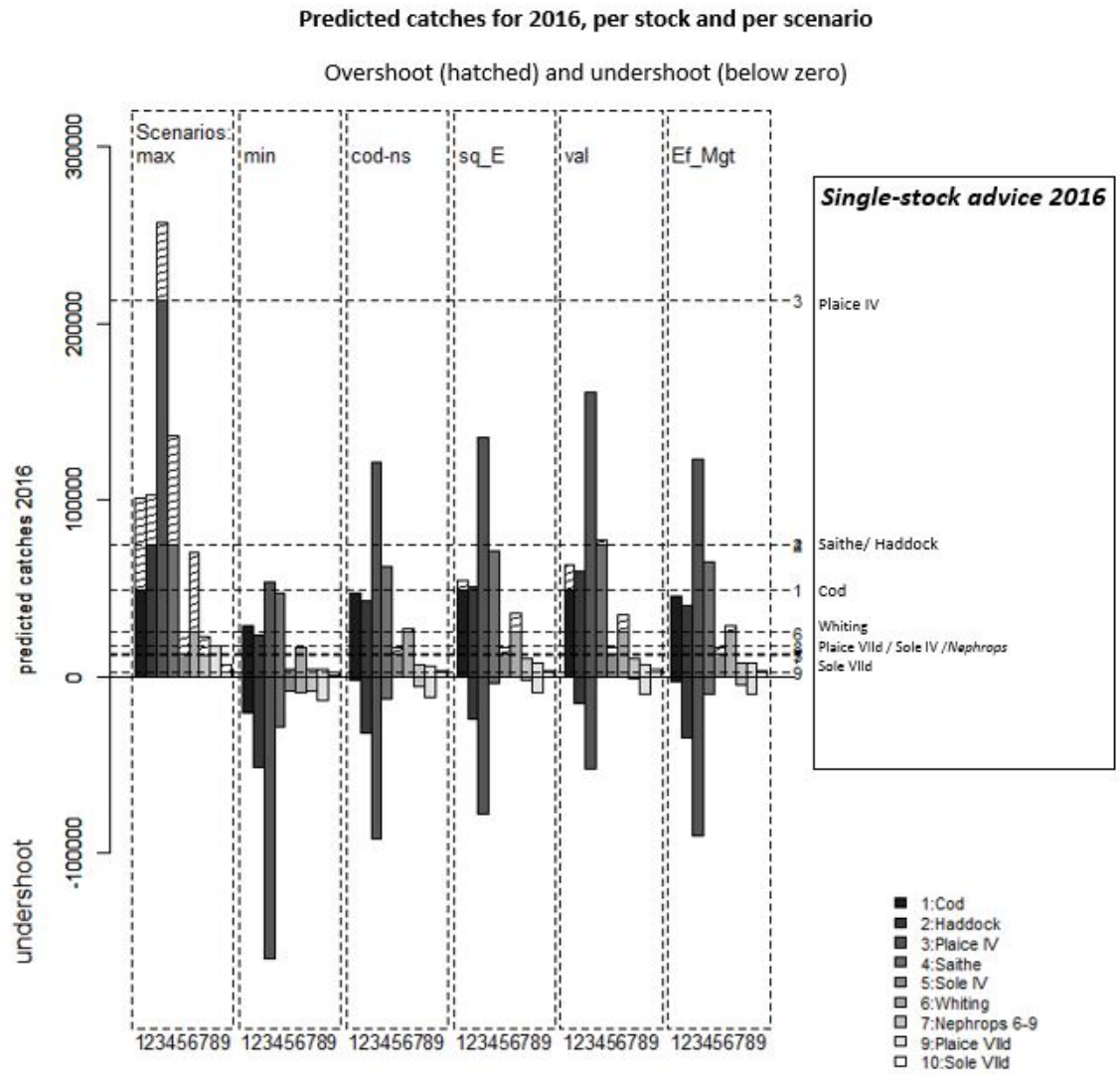


Figure 2.5.2.2.a TAC year results (2016). Fcube estimates of potential catches by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single-stock advice. Bars below the value of 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.

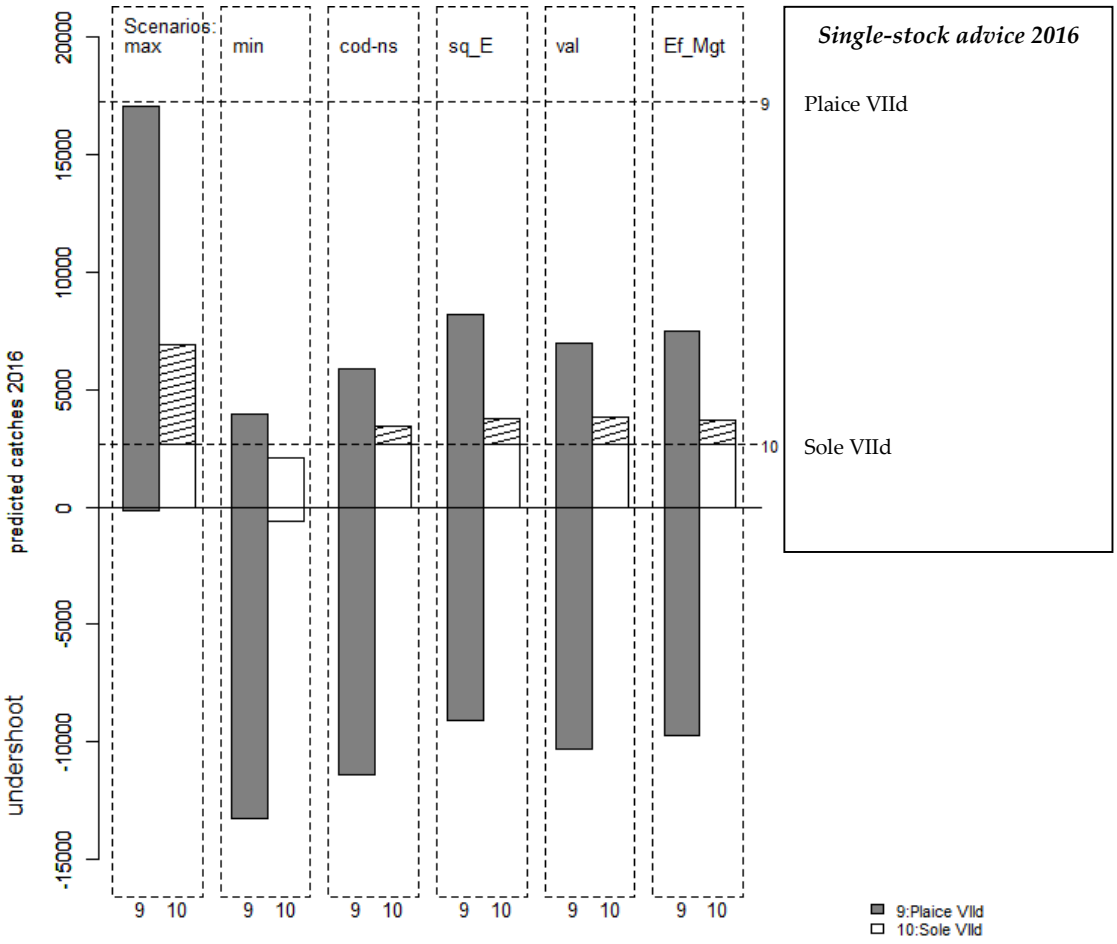


Figure 2.5.2.2.b TAC year results for the stocks subject to lower landings (detail from Figure 4.2.2.2.1). Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the single-stock catch advice for 2016. Bars below the value of zero show the scale of undershoot (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.

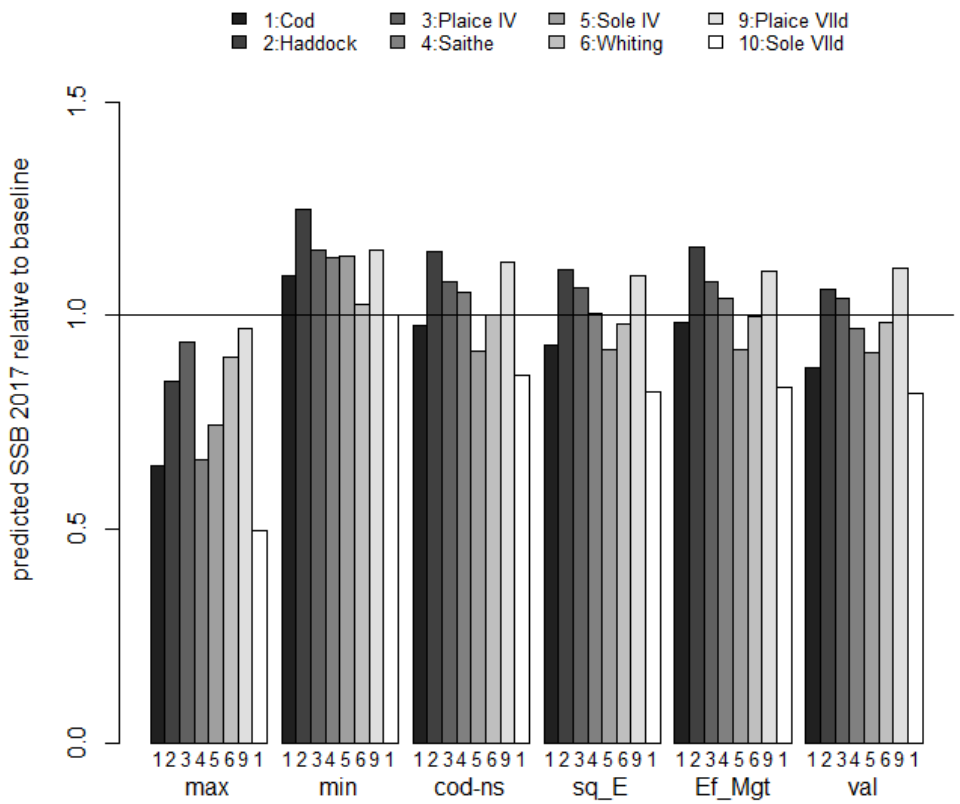


Figure 2.5.2.2.c Estimates of potential SSB at the start of 2017 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2017). Nephrops are not included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

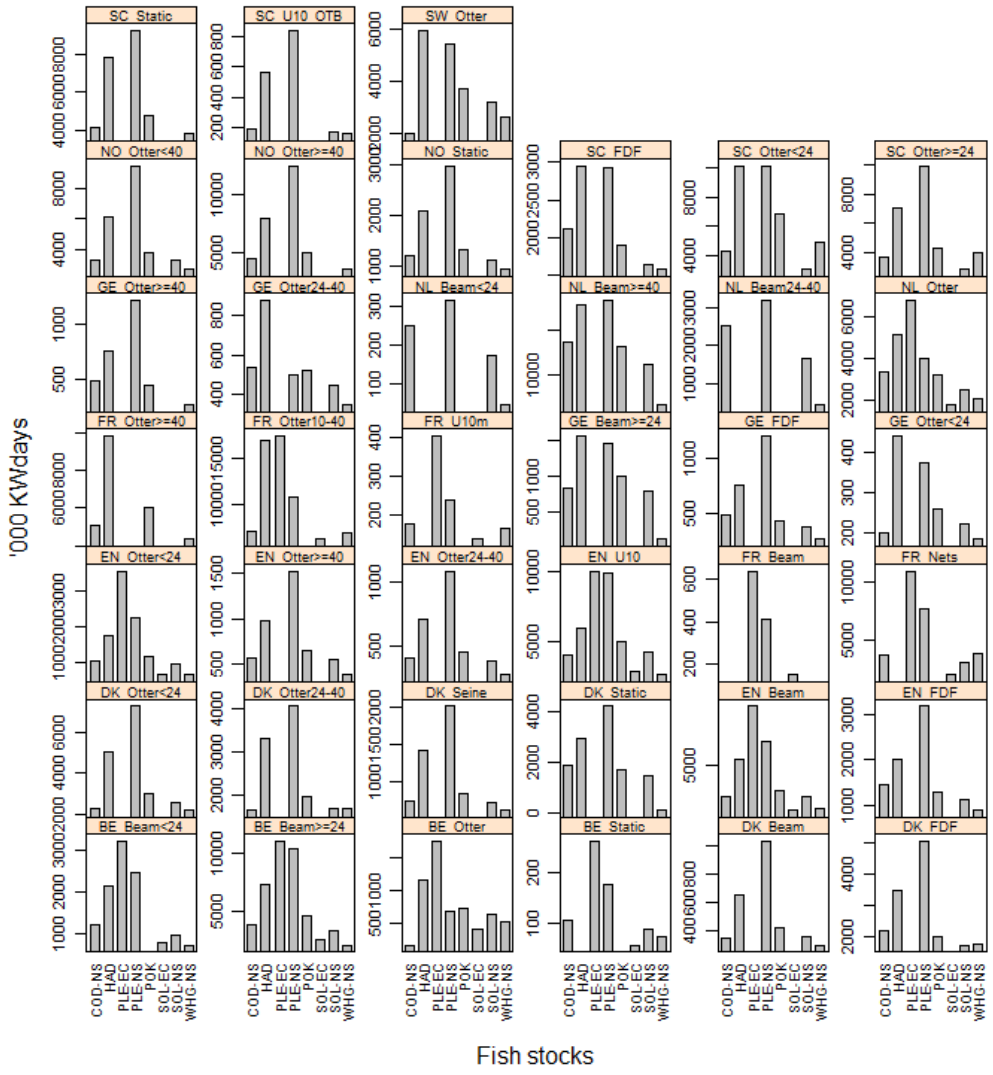


Figure 2.5.2.2.d TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2016 (baseline run). Finfish species.

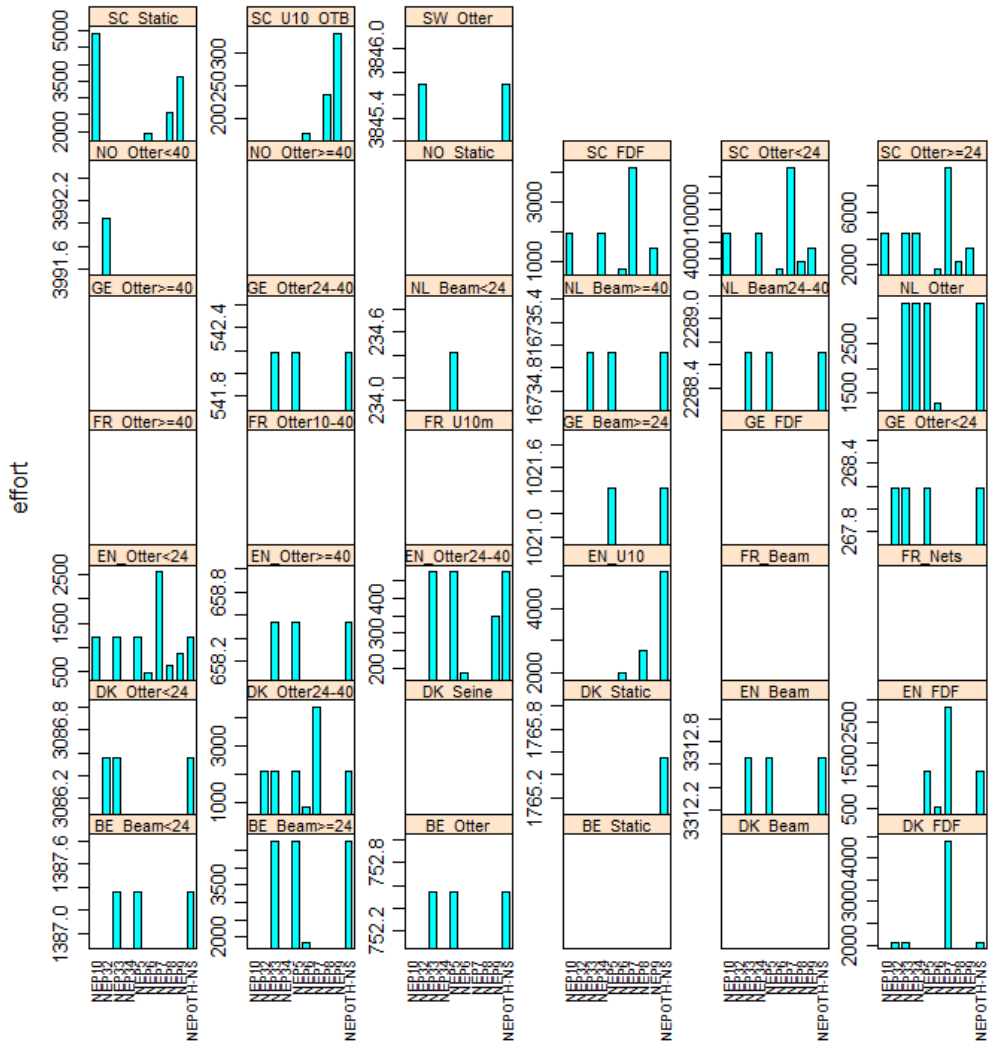


Figure 2.5.2.2.e. TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2016 (baseline run). *Nephrops* FUs.

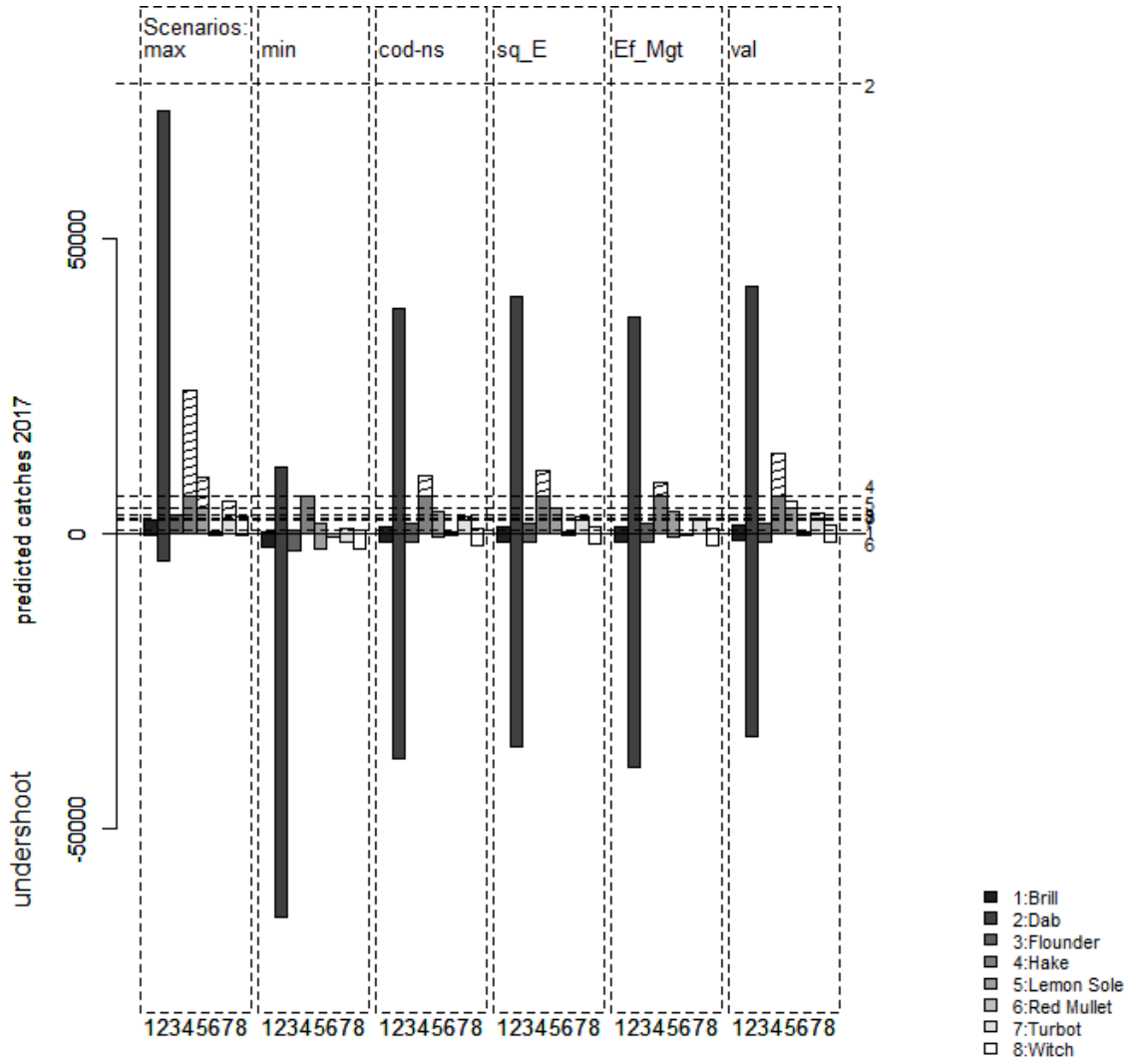


Figure 2.4.2.2.1. TAC year results. Estimates of potential catch by stock after applying the *status quo* effort scenario in the intermediate year followed by the Fcube scenarios. Stocks shown do not influence the mixed fisheries projections but potential catches are calculated using fleet effort results from the scenarios and the cpue of métiers from the final data year. Horizontal lines correspond to the single-stock catch 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.

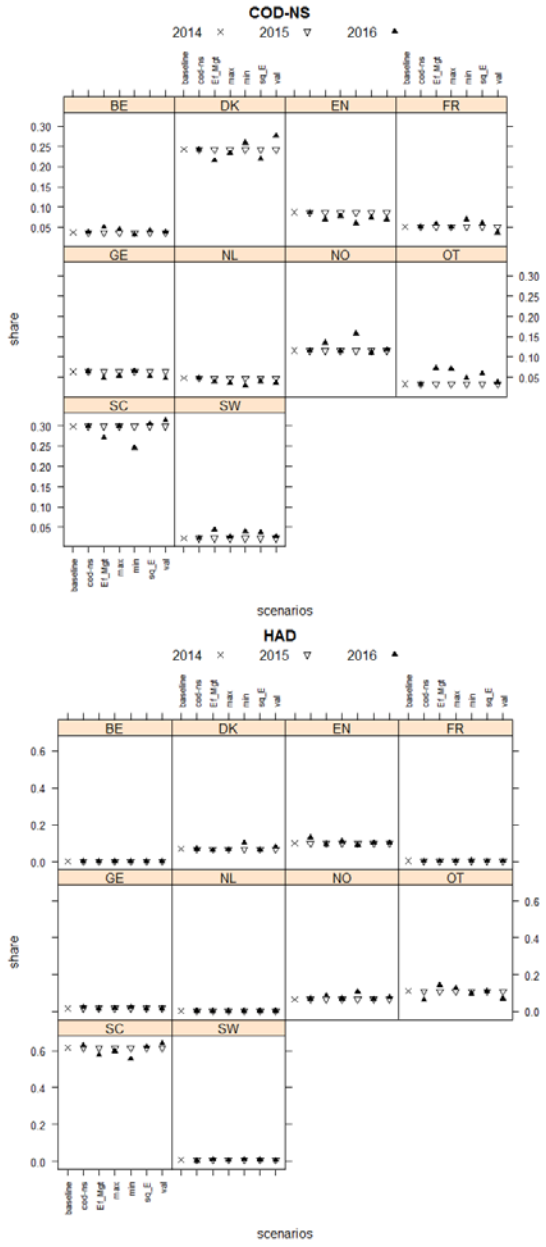


Figure 2.5.2.2.2. Test for relative stability. Changes of relative share of species' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

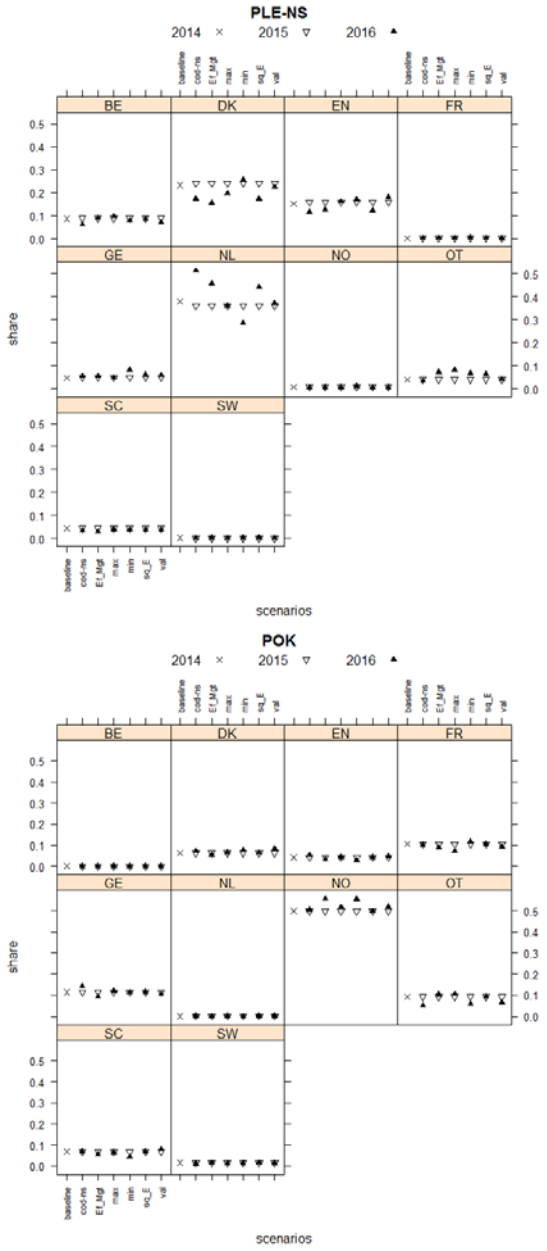


Figure 2.5.2.2.2 (cont). Test for relative stability. Changes of relative share of species' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

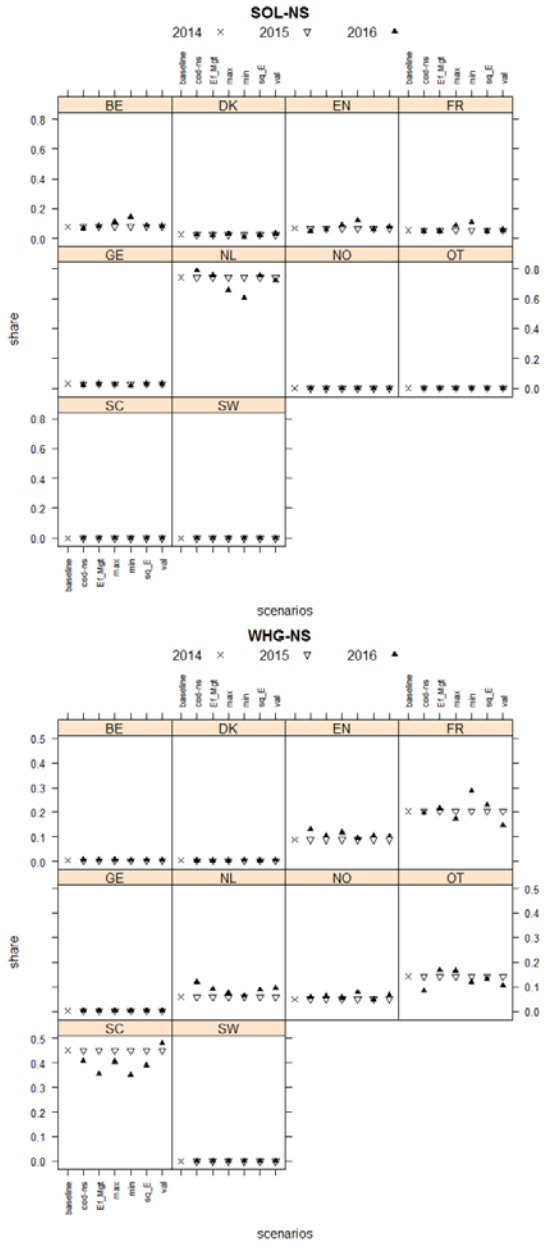


Figure 2.5.2.2.2 (cont). Test for relative stability. Changes of relative share of species' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

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, megrims, 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 VIIe and VIIfg) and rays (VIIf). 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 (VIIhjk).

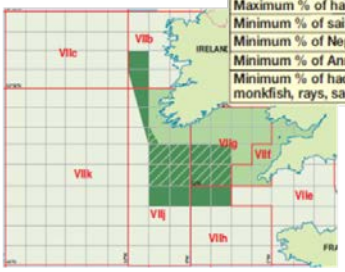
The mixed gadoid fishery predominately takes place in ICES areas VIIf and VIIg with these areas responsible for > 75% of the landings of each cod, haddock and whiting. Landings are predominately by French and Irish vessels, though UK vessels also take significant landings of these species.

3.1.1 Management measures

ICES advice in 2015 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 (VIIe; 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 ≥ 15m vessels fishing for demersal species in Subarea VII with additional effort ceiling specifications for an area to the South and West of Ireland known as the 'Biologically Sensitive Area' for vessels ≥ 10m.

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 VII 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.



Note on changes to TCM regulations during 2015

The European Commission will update TCM legislation during 2015 and users of this map are cautioned that TCM requirements may change from those represented on this chart. For example an increase in Square Mesh Panel mesh size is anticipated in the Celtic Sea.

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+
Twine thickness	4mm double or single 6mm								
Headline Panel (mm) (Beam Trawlers see footnote 1)	-	-	-	-	-	-	-	-	-
Square mesh panel (mm)	80	-	-	-	110	110	110	100	-
Maximum number of meshes in codend circumference	120	120	100	100	120	120	100	100	100
Catch Composition	-	Either - Or		-	Either - Or		-	-	-
Maximum % of cod allowed. (Council Reg 39/2013)	-	-	-	-	-	-	-	-	-
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 [2]	-	-	-	70 [2]	-	-
Minimum % of haddock, hake, whiting, megrim, monkfish, rays, saithe and Nephrops	-	-	-	-	-	-	-	-	-

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

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 Trevose 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.

3.2 Fcube

3.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.* (2007); 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.

Stock	Assessment	Forecast
Cod VIIe-k	Age-bases analytical assessment (FLR 2.x FLXSA)	FLR STF
Haddock VIIbc,e-k	ASAP (Age Structured Assessment Programme; NOAA toolbox)	FLR STF
Whiting VIIbc,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 Mixed Fisheries Annex (Annex 7).

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 2015, 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 six options (or scenarios) were included in the advice:

1) **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.
2) **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.
3) **cod**: All fleets set their effort corresponding to that required to land their quota share of cod, regardless of other catches.
4) **had:** All fleets set their effort corresponding to that required to land their quota share of haddock, regardless of other catches.
5) **whg:** All fleets set their effort corresponding to that required to land their quota share of Whiting, regardless of other catches.
6) **sq_E**: The effort is set equal to the effort in the most recently recorded year for which landings and discard data are available.

Consideration was given to including the *Nephrops* stocks (FUs 16, 17, 18, 19, 20-21 and 22) in the Celtic Sea in the mixed fisheries forecasts. 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).

Initial investigation indicated it would be possible to include the *Nephrops* FUs in the Celtic Sea as all have under-water television (UWTV) survey estimates of abundance, harvest rates and MSY targets. However, there are two further complicating factors which first need to be addressed; i) the latest abundance estimates (and single stock advice sheets) are produced following the summer UWTV surveys, after WGMIXCFISH meets. ii) a single *Nephrops* TAC applies to the entire Area VII, which includes two FUs in the Irish Sea (sub-area VIIa, 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 VII TAC. It was agreed to investigate how best to incorporate *Nephrops* in the forecasts at the October methods meeting, so that *Nephrops* can be incorporated in future advice.

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 (2015b). 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-2015 before considerations by ACOM.

Recent trends are described on a stock-by-stock basis in ICES (2015b), 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. In addition Table 3.3.1.2 list the final advised TACs for 2016 and forecast SSBs in 2017.

3.3.1.2.1 Analytical stocks

Species	Area	Stock status	Summary	Advice 2016
Cod	VIIe-k (Celtic Sea)	Fishing presure 2012 2013 2014 MSY (F_{MSY}) ✗ ✗ ✗ Above Precautionary approach (F_{pa}, F_{lim}) o o o Increased risk Stock size 2013 2014 2015 MSY ($B_{trigger}$) ✓ ✗ ✗ Below trigger Precautionary approach (B_{pa}, B_{lim}) ✓ ✗ o Increased risk	Recruitment has been highly variable over time with occasional very high recruitment (e.g. 1987 and 2010). The 2011 and 2012 year classes are estimated well below the average of the time-series, but the 2013 year class is well above average. SSB is close to Blim in 2014 and 2015. Fishing mortality shows a declining trend since 2005 with some fluctuations but remains above FMSY.	ICES advises that when the **MSY approach** is applied, **landings in 2016 should be no more than 3569 tonnes.** ICES cannot quantify the corresponding total catches because of variable discard rates in the recent past.
Haddock	VIIbc, VIIe-k (Celtic Sea)	Fishing pressure 2012 2013 2014 MSY (F_{MSY}) ✗ ✗ ✗ Above Precautionary approach (F_{pa}, F_{lim}) ✓ ✓ ✓ Harvested sustainably Stock size 2013 2014 2015 MSY ($B_{trigger}$) ✓ ✓ ✓ Above trigger Precautionary approach (B_{pa}, B_{lim}) ✓ ✓ ✓ Full reproductive capacity	The Spawning stock biomass (SSB) peaked in 2011 as the very strong 2009 year class matured, this was followed by three years of below-average recruitment which led to a rapid decline in SSB after 2011. Recruitment in 2013 was well above average, but not as high as the 2009 cohort. Fishing mortality has been above FMSY for the full time-series.	ICES advises that when the **MSY approach** is applied, **catches in 2016 should be no more than 8590 tonnes.** If discard rates do not change from the average of the full time series (1993-2014), this implies **landings of no more than 6078 t.**
Whiting	VIIbc, VIIe-k (Celtic Sea)	Fishing pressure 2012 2013 2014 MSY (F_{MSY}) ✓ ✓ ✓ Increased risk Precautionary approach (F_{pa}, F_{lim}) ? ? ? Undefined Stock size 2013 2014 2015 MSY ($B_{trigger}$) ✓ ✓ ✓ Above trigger Precautionary approach (B_{pa}, B_{lim}) ✓ ✓ ✓ Full reproductive capacity	The spawning-stock biomass (SSB) shows an increasing trend from 2008 remains well above MSY Btrigger. Fishing mortality has a declining trend since 2007 and is estimated to be at the fishing mortality rate for maximum sustainable yield (Fmsy) in 2014. Recruitment between 2010 and 2012 was below average whereas the 2013 year class is estimated to be the second highest in the series.	ICES advises that when the **MSY approach** is applied, **catches in 2016 should be no more than 19 076 tonnes**

3.3.1.2.2 Nephrops stocks (not included in May advice – not stock status comes from 2014 advice)

Species	Area	Stock status	Summary	Advice 2016
Nephrops	FU16	Fishing pressure 2011 2012 2013 MSY (F_{MSY}) ? ✓ ✓ Appropriate Precautionary approach (Fpa, Flim) ? ? ? Undefined Stock size 2012–2014 MSY ($B_{trigger}$) ? Undefined Precautionary approach (Bpa, Blim) ? Undefined Qualitative evaluation → Stable (based on UWTV abundance)	NA	NA
Nephrops	FU17	Fishing pressure 2011 2012 2013 MSY (F_{MSY}) ✓ ✗ ✗ Above target Precautionary approach (Fpa, Flim) ? ? ? Undefined Stock size 2012–2014 MSY ($B_{trigger}$) ? Undefined Precautionary approach (Bpa, Blim) ? Undefined Qualitative evaluation ↘ Decreasing	NA	NA
Nephrops	FU19	Fishing pressure 2011 2012 2013 MSY (F_{MSY}) ✓ ✗ ✗ Above target Precautionary approach (Fpa, Flim) ? ? ? Undefined Stock size 2012–2014 MSY ($B_{trigger}$) ? Undefined Precautionary approach (Bpa, Blim) ? Undefined Qualitative evaluation → Stable	NA	NA
Nephrops	FU20-21	Fishing pressure 2011 2012 2013 MSY (F_{MSY}) ? ? ? Not defined Precautionary approach (Fpa, Flim) ? ? ? Undefined Qualitative evaluation ? ? ✓ Below possible reference points Stock size 2012–2014 MSY ($B_{trigger}$) ? Not defined Precautionary approach (Bpa, Blim) ? Not defined Qualitative evaluation ↗ Increasing	NA	NA
Nephrops	FU22	Fishing pressure 2011 2012 2013 MSY (F_{MSY}) ✓ ✓ ✓ Appropriate Precautionary approach (Fpa, Flim) ? ? ? Unknown Stock size 2012–2014 MSY ($B_{trigger}$) ? Undefined Precautionary approach (Bpa, Blim) ? Undefined Qualitative evaluation → Stable	NA	NA
Nephrops	FU22	NA	NA	NA

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. The only exception was for Ireland, where data was submitted to InterCatch at DCF level 4 only (up to gear) and further disaggregation of landings to the target species level was desirable to distinguish the fisheries in the mixed fisheries forecasts.

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 was 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 weight 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, 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, with any métiers with effort and no catch also binned 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 sub-area (e.g. VIIb).

- A similar aggregating procedure of as for the fleets was performed, where any métier that catches < 1% of a métiers catch of each stock was binned into an "OTH" métier.

The final data used contained 15 national fleets (plus the OTH fleet) from five countries, covering catch and effort for the years 2013 and 2014. These fleets engage in one to eight different métiers each, resulting in 67 combinations of country*fleet*métier*area catching cod, haddock, and whiting (Table 4.4.2.2.2). 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:

- Belgium: Retention of a single fleet, 24–40m vessels utilizing beam trawls to target demersal species, the primary Belgium fleet within the Celtic Sea
- England: Beam trawling vessels 24–40m for demersal species; otter trawlers of 10–24m differentiating between demersal and crustacean targeting. Division of the static gear fleet into set gillnet, and trammel net fleets both targeting demersal fish in addition to retention of longline finfish fishing.
- France: Use of six fleets, three where the gear (and target species) are not specified which are then distinguished by vessel lengths, into 10–24m, 24–40m and "all" (other lengths, mostly < 10 m) vessels. The remaining three fleets use otter trawls distinguished by vessel length, 10–24m and 24–40m which both target demersal fish, the last contains vessels of all lengths targeting "other" species.
- Ireland: Distinction between 10–24m and 24–40m otter trawling fleets each having segments targeting demersal fish, crustaceans, and "others". Two additional fleets were retained: 24–40m beam trawling vessels targeting demersal fish, and a static gear fleet with segments targeting demersal fish with set gillnets and an "others" gear category.
- Northern Ireland: Retention of a single fleet of 24–40m vessels utilising unspecified gears.

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 (VIIb, VIIc, VIIe, VIIf, VIIg, VIIh, VIIj, VIIk). The list of fleets, métiers with their catch (tonnes, all species) and effort are provided in table 3.4.2.b.

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 (Table 3.4.2 and Figure 3.4.2). Some landings may not be allocated to fleets, due to for example 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 2013 and 2014 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 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 in their effort and catches. Effort by fleet in absolute levels (Table 3.4.2; not presented in 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 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

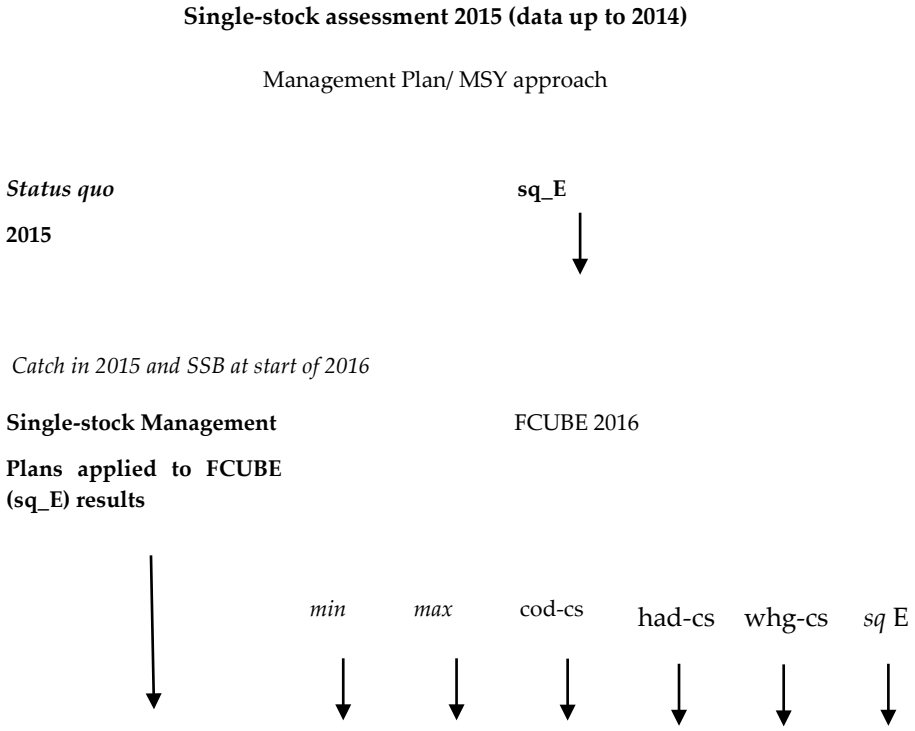
3.5.1.2.1 Fcube analyses of the intermediate year (2015)

As a *status quo* effort assumption was used an FCube scenario analysis was not performed for the intermediate year. This results in the application of FCube to the TAC year only (2016). It was considered a more appropriate 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 (2016)

The working group adopted a forecast approach for the intermediate year on the basis of *Status quo* effort, as per the North Sea forecasts. A *status quo* effort assumption is considered a plausible assumption and is more in line with the standard single-stock short-term forecasting approach. Therefore the mixed fishery analysis used a *status quo* effort assumption for the intermediate year (2015), with the Fcube scenarios used for the TAC year (2016).

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 2014 through the intermediate year and into the TAC year. It can be seen from Figure 3.5.2.1.a that cod requires the biggest reduction in F, indicating the potential for it to be the 'choke' species for the fisheries that catch cod. The change in F on cod from 2014 to 2016 implies a reduction in fishing effort (from F = 0.57 in 2014 to F = 0.31 in 2016) of –46% which is a level of fishing effort lower than to catch the other stocks. Conversely, whiting F in 2014 and at FMSY in 2016 are very similar (F = 0.32) which implies levels of effort in 2016 at around the same as those observed in 2014, 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 stocks advices.

3.5.2.2 Mixed fisheries analyses

The full overview of the Fcube projections to 2016 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 2016 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 6005 tonnes in 2015 (F2015 assumed to equal F2014), and 3547 tonnes in 2016. The resulting SSB in 2017 is estimated to be 9894 tonnes.

WGMIXFISH assumes *status quo* effort (**sq_E**) in 2014 resulting in no change in F compared to 2015 and landings of 5378 tonnes in 2015. If it is assumed the **sq_E** scenario was used as the basis for the single species advice, this would lead to TAC advice of 6253 tonnes. The resulting SSB in 2017 is estimated to be 11 440 tonnes, 16% lower than the resulting SSB following the single species advice MSY approach.

The baseline run for **haddock**, which follows the single-stock ICES advice, assumes catches of 9885 tonnes in 2015 (F2015 assumed to equal F2014), and 8590 tonnes in 2016. The resulting SSB in 2017 is estimated to be 22 776 tonnes. WGMIXFISH assumes *status quo* effort (**sq_E**) in 2015 resulting in a slight decrease in F compared to 2014 and catches of 15 329 tonnes in 2015. If it is assumed the **sq_E** scenario was used as the basis for the single species advice, this would lead to TAC advice of 9962 tonnes. The resulting SSB in 2017 is estimated to be 21 841 tonnes, 13% lower than the resulting SSB following the single species advice MSY approach.

The baseline run for **whiting**, which follows the single-stock ICES advice, assumes landings of 10 879 tonnes in 2015 (F2015 assumed to equal F2014), and 19 077 tonnes in 2016. The resulting SSB in 2017 is estimated to be 67 569 tonnes. WGMIXFISH assumes *status quo* effort (**sq_E**) in 2014 resulting in a slight increase in F compared to 2015 and landings of 13 641 tonnes in 2015. If it is assumed the **sq_E** scenario was used as the basis for the single species advice, this would lead to TAC advice of 18 038 tonnes, representing the same F value but applied to a smaller biomass than in the baseline. The resulting SSB in 2017 is estimated to be 64 089 tonnes, 3% lower than the resulting SSB following the single species advice MSY approach.

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. In the "Minimum" scenario, the most limiting stocks are cod, haddock and whiting for fleets representing 83%, 12% and 5% of the effort in 2014 respectively. In the "Maximum" scenario, the least limiting stock is whiting, cod and haddock for fleets representing 92%, 6% and 2% of the effort in 2014, respectively. The maximum scenario is close to the *Status quo* Effort as well as 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 **min** and **cod** scenarios do, however, give similar results (Table 3.5.2.2.b and Figure 2.5.2.2.a) because cod is the limiting species for such a high percentage of fleet effort.

Other scenarios represent intermediate plausible scenarios reflecting basic current management measures and also the *status quo* option. 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 2016 of the Fcube scenarios are shown in Figure 3.5.2.2.b. The **min** and **cod** scenarios result in SSBs slightly higher than the respective single stock forecasts for all stocks (including cod, due to the different intermediate year assumption). The **max**, **whg** and **sq_E** scenario result in SSBs lower than the stocks respective single-stock forecasts (though all stocks are still forecast to remain above their respective biomass reference points).

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 cod quota in 2016 than for haddock, 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 2016.

3.5.2.2.1 Nephrops stocks

The WG was requested under ToR b to consider how advice released for *Nephrops norvegicus* issued in October could be taken into account in mixed fisheries projections. Due to time constraints, the WG was unable to explore this. This term of reference will be explored at WGMIXFISH-Methods in October.

3.5.2.2.2 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 2014. As a cross check, 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 only minor deviations across all scenarios. However, such deviations do arise under the **min** and **max** scenarios because 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.

Table 3.3.1.2. Celtic Sea. Summary of the 2016 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) 2015	Catch– advice for 2016	Landings– advice for 2016	F/Harvest ratio for 2015	F/ Harvest ratio for 2016	SSB 2016	SSB 2017	Rational
Cod VIIe-k	5 072**		3 547	0.66	0.31	9 894	13 708	MSY
Haddock VIIbc, VIIe-k	8 342^	8 590	6 078	0.58	0.4	22 776	25 203	MSY
Whiting VIIbc, VIIe-k	17 742*	19 076	15 395	0.25	0.32	67 569	66 187	MSY
Nephrops FU16	1 850			5.0				MSY
Nephrops FU17	21 619***			10.5				MSY
Nephrops FU19	21 619***			8.1				MSY
Nephrops FU20-21	21 619***			5.5				Conservative
Nephrops FU22	21 619***			10.9				MSY
Nephrops FU18+VIIOTH	21 619***							na

**** Applies to Divisions VIIb,c,e–k, Subareas VIII, IX, and X, and EU waters of CECAF 34.1.1.**

^ Applies to Divisions VIIb–k and Subareas VIII, IX, and X.

*** TAC covers Subarea VII (except Division VIIa).**

*****TAC for whole of Subarea VII.**

Table 3.4.2.a. Celtic Sea. Métiers consistent with DCF métier level 5. Mixed-fisheries métiers are further disaggregated into areas: VIIb, VIIc, VIIe, VIIf, VIIg, VIIh, VIIj and VIIk.

GEAR	TARGET SPECIES	MIXED–FISHERIES MÉTIERS (PLUS AREA)
Gillnets	Demersal fish	GNS_DEF
Trammel nets	Demersal fish	GTR_DEF
Longlines	Finfish	LLS_FIF
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.

		2013		2014	
fleet	metier	Effort	Catch	Effort	Catch
BE_Beam_24<40m	OTH	14	0.1	21	0.54
	TBB_DEF_VIIe	356	11.33	143	3.1
	TBB_DEF_VIIf	1143	243.21	1091	376.3
	TBB_DEF_VIIg	1210	173.31	658	44
EN_Beam_24<40m	TBB_DEF_VIIe	1367	49.91	1587	253.99
	TBB_DEF_VIIf	263	42.25	0	0
	TBB_DEF_VIIh	872	97.68	0	0
EN_Otter_10<24m	OTB_CRU_VIIe	1025	497.87	1381	732.23
	OTB_DEF_VIIe	397	643.95	343	411.56
	OTB_DEF_VIIf	22	20.39	0	0
	OTB_DEF_VIIh	6	18.55	0	0
	OTH	131	15.71	196	21.34
EN_Static_all	GNS_DEF_VIIe	666	23.21	628	105.77
	GNS_DEF_VIIf	274	40.77	0	0
	GNS_DEF_VIIh	115	40.85	0	0
	GNS_DEF_VIIj	41	19.62	0	0
	GTR_DEF_VIIe	27	1.83	48	13.08
	GTR_DEF_VIIh	37	4.83	0	0
	LLS_FIF_VIIe	298	16.19	302	9.59
	OTH	507	2.62	452	1.25
FR_Other_10<24m	MIS_MIS_VIIe	6730	231.28	1464	259.36
	MIS_MIS_VIIg	442	361.94	3	5.78
	MIS_MIS_VIIh	1193	280.39	35	23.79
	OTH	1452	8.93	68	11.86
FR_Other_24<40m	MIS_MIS_VIIb	268	22.42	12	0.15

		2013		2014	
	MIS_MIS_VIIc	667	31.62	27	0.7
	MIS_MIS_VIIe	393	167.01	403	194.6
	MIS_MIS_VIIf	46	29.04	26	5.48
	MIS_MIS_VIIg	335	9.49	4	3.32
	MIS_MIS_VIIh	344	328.09	90	73.13
	MIS_MIS_VIIj	1827	140.89	28	1.92
	OTH	614	1.69	0	0
FR_Other_all	OTH	0	0	16720	875.82
FR_Otter_10<24m	OTB_DEF_VIIe	5556	2485.32	2771	1917.76
	OTB_DEF_VIIf	832	1160.02	557	1008.08
	OTB_DEF_VIIg	2236	3989.53	356	687.93
	OTB_DEF_VIIh	4644	2282.43	803	801.12
	OTH	464	41.76	140	19.78
FR_Otter_24<40m	OTB_DEF_VIIb	537	321.6	318	246.3
	OTB_DEF_VIIc	469	115.17	413	158.85
	OTB_DEF_VIIe	2433	1724.51	1828	1705.67
	OTB_DEF_VIIf	570	1048.91	539	1513.16
	OTB_DEF_VIIg	781	1864.72	588	1618.68
	OTB_DEF_VIIh	1667	1506.82	1410	1679.27
	OTB_DEF_VIIj	1190	251.04	831	382.87
	OTH	55	123.22	37	1.8
FR_Otter_all	OTH	0	0	5047	3313.09
IE_Beam_24<40m	OTH	16	2	8	1.04
	TBB_DEF_VIIg	866	269.78	763	464.05
IE_Otter_10<24m	OTB_CRU_VIIg	703	453.62	1134	372.99
	OTB_DEF_VIIb	325	359.41	803	436.2
	OTB_DEF_VIIg	1985	3823.16	2825	3965.98
	OTB_DEF_VIIj	984	683.73	1365	763.44
	OTH	811	149.66	1553	2380.25
IE_Otter_24<40m	OTB_CRU_VIIg	493	264	509	130.7
	OTB_DEF_VIIb	322	253.64	466	347.21
	OTB_DEF_VIIg	539	1817.71	830	2001.06
	OTB_DEF_VIIh	199	53.08	0	0
	OTB_DEF_VIIj	467	83.01	548	78.03
	OTH	1504	63.13	2041	1792.22
IE_Static_all	GNS_DEF_VIIb	51	9.31	0	0
	GNS_DEF_VIIg	237	240.83	0	0
	GNS_DEF_VIIj	244	153.12	0	0
	OTH	0	0	501	454.63
NI_Other_24<40m	MIS_MIS_VIIb	7	76.73	17	186.61
	MIS_MIS_VIIj	1	0.88	0	0
OTH_OTH	OTH	1000	7464.21	1000	1846.63

Table 3.4.2. 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.LAND	RATIO.DISC
2013	COD-CS	6290	6148	-142	0	389	389	0.98	Inf
2014	COD-CS	3879	3751	-128	0	725	725	0.97	Inf
2013	HAD-CS	13424	12816	-608	2085	1642	-443	0.95	0.79
2014	HAD-CS	9854	9511	-343	3177	3413	236	0.97	1.07
2013	WHG-CS	12402	11808	-594	2512	2189	-323	0.95	0.87
2014	WHG-CS	12847	12898	51	3895	3497	-398	1	0.9

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

		COD–CS	HAD–CS	WHG–CS
2015	Fbar	0.66	0.58	0.25
	FmultVsF14	1.15	0.98	0.78
	Landings	6 005	9 885	10 879
	SSB	7 676	33 387	83 052
2016	Fbar	0.31	0.40	0.32
	FmultVsF14	0.54	0.67	1
	Landings	3 547	8 590	19 077
	SSB	9 894	22 776	67 569
2017	SSB	13 708	25 203	66 190

Table 3.5.2.1.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–CS	HAD–CS	WHG–CS
2015	Landings			
	Baseline	6 005	9 885	10 879
	ICES	6 005	9 885	10 879
	% difference	0.00%	0.00%	0.00%
2016	Total Catches*			
	Baseline	3 547	8 590	19 077
	ICES	3 569	8 590	19 076
	% difference	-0.62%	0.00%	0.01%

***COD-CS landings only**

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

	year	scenarios	COD-CS	HAD-CS	WHG-CS
landings	2015	baseline	6005	9885	10879
Fbar	2015	baseline	0.66	0.58	0.25
	2016	baseline	0.31	0.40	0.32
FmultVsF14	2015	baseline	1.15	0.98	0.78
	2015	sq_E	1.00	0.99	1.01
	2016	baseline	0.54	0.67	1.00
	2016	cod-cs	0.54	0.54	0.54
	2016	had-cs	0.69	0.67	0.67
	2016	max	1.02	1.04	1.03
	2016	min	0.52	0.53	0.53
	2016	sq_E	1.00	1.00	1.00
	2016	whg-cs	0.97	1.01	1.00
Fbar	2015	sq_E	0.57	0.59	0.32
	2016	cod-cs	0.31	0.32	0.17
	2016	had-cs	0.39	0.40	0.21
	2016	max	0.58	0.62	0.33
	2016	min	0.30	0.32	0.17
	2016	sq_E	0.57	0.60	0.32
	2016	whg-cs	0.55	0.60	0.32
landings	2015	sq_E	5378	9962	13641
	2016	baseline	3547	8590	19077
	2016	cod-cs	3747	7108	10398
	2016	had-cs	4644	8553	12693
	2016	max	6362	12196	18463
	2016	min	3622	6964	10236
	2016	sq_E	6253	11869	18038
	2016	whg-cs	6092	11941	18070
Ld_MgtPlan	2016	sq_E	3747	8553	18070
catches	2015	sq_E	5378	15329	18794
	2016	baseline	3547	8590	19077
	2016	cod-cs	3747	7108	10398
	2016	had-cs	4644	8553	12693
	2016	max	6362	12196	18463
	2016	min	3622	6964	10236
	2016	sq_E	6253	11869	18038
	2016	whg-cs	6092	11941	18070
ssb	2015	baseline	7676	33387	83052
	2016	baseline	9894	22776	67569
	2016	sq_E	10583	22657	64129
	2017	cod-cs	14389	26577	70835
	2017	had-cs	13325	25131	68802
	2017	max	11313	21519	63716
	2017	min	14538	26721	70978
	2017	sq_E	11440	21841	64089
	2017	whg-cs	11627	21769	64061
ssb_MgtPlan	2016	sq_E	10583	22657	64129

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

	SINGLE–STOCK CATCHES	CATCHES PER MIXED–FISHERIES SCENARIO 2016 RELATIVE TO THE SINGLE STOCK ADVICE					
Stock	advice 2016*	"Max"	"Min"	"Cod-cs"	"Had-cs"	"Whg-cs"	"Sq_E"
Cod VIIe-k	3.560	1.79	1.02	1.05	1.30	1.71	1.76
Haddock VIIbc,VIIe-k	8.590	1.51	0.87	0.88	1.06	1.48	1.47
Whiting VIIbc,VIIe-k	19.076	0.97	0.54	0.55	0.67	0.95	0.95

***Weights in thousand tonnes.**
Advised catches no more than the indicated value.

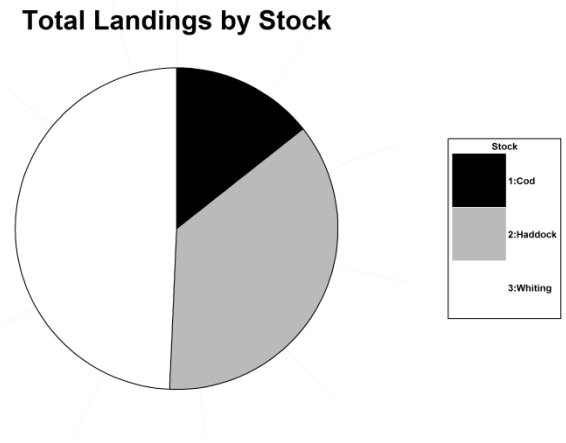


Figure 3.4.1.a. Celtic Sea. Distribution of landings of those stocks included in the mixed fisheries projections.

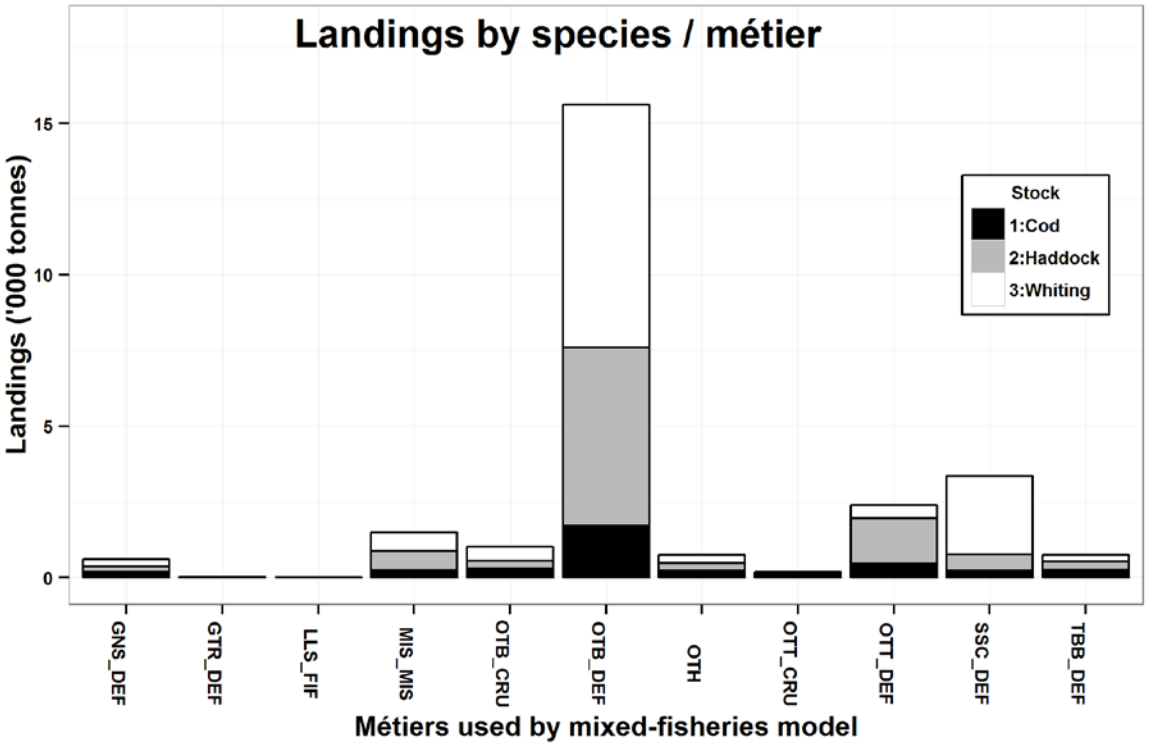


Figure 3.4.1.b. Celtic Sea. Landings distribution of species by métier with landings consisting of ≥ 1% of any of the stocks 1–10 in 2014 Note: The "other" (OTH) displayed here is a mixed category consisting of (i) landings without corresponding effort and (ii) landings of any combination of fleet and 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 VI and VIa respectively.

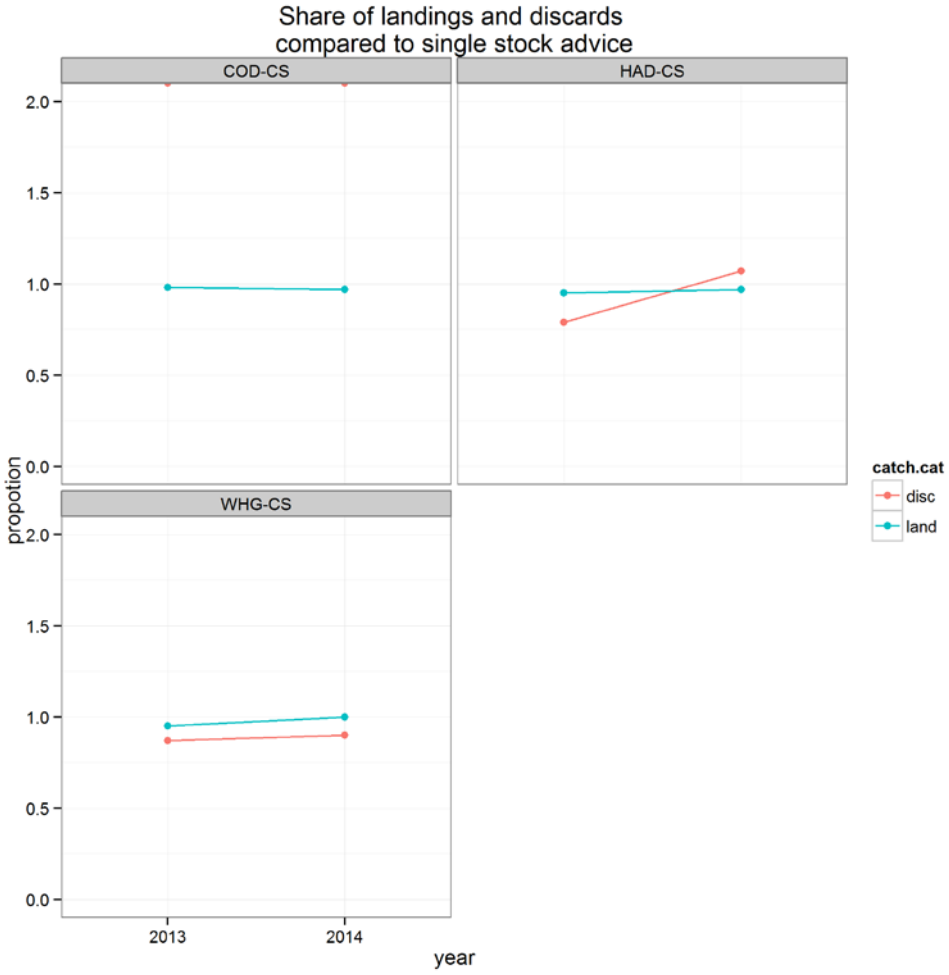


Figure 3.4.2. Celtic Sea. Ratio between the sum of landings and discards across fleets used in the MIXFISH analysis and the landings and discards estimated by the WGCSE stock assessments.

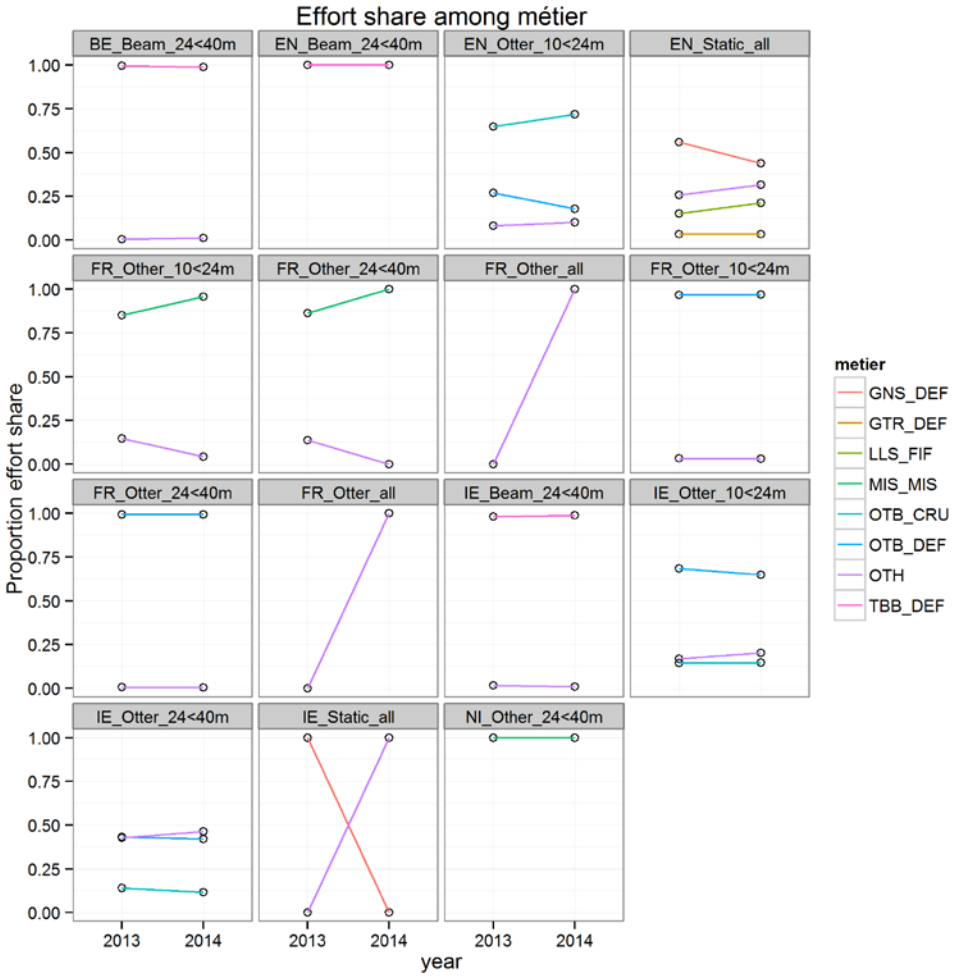


Figure 3.4.3.a. Effort share (in proportion) by métier for each fleet.

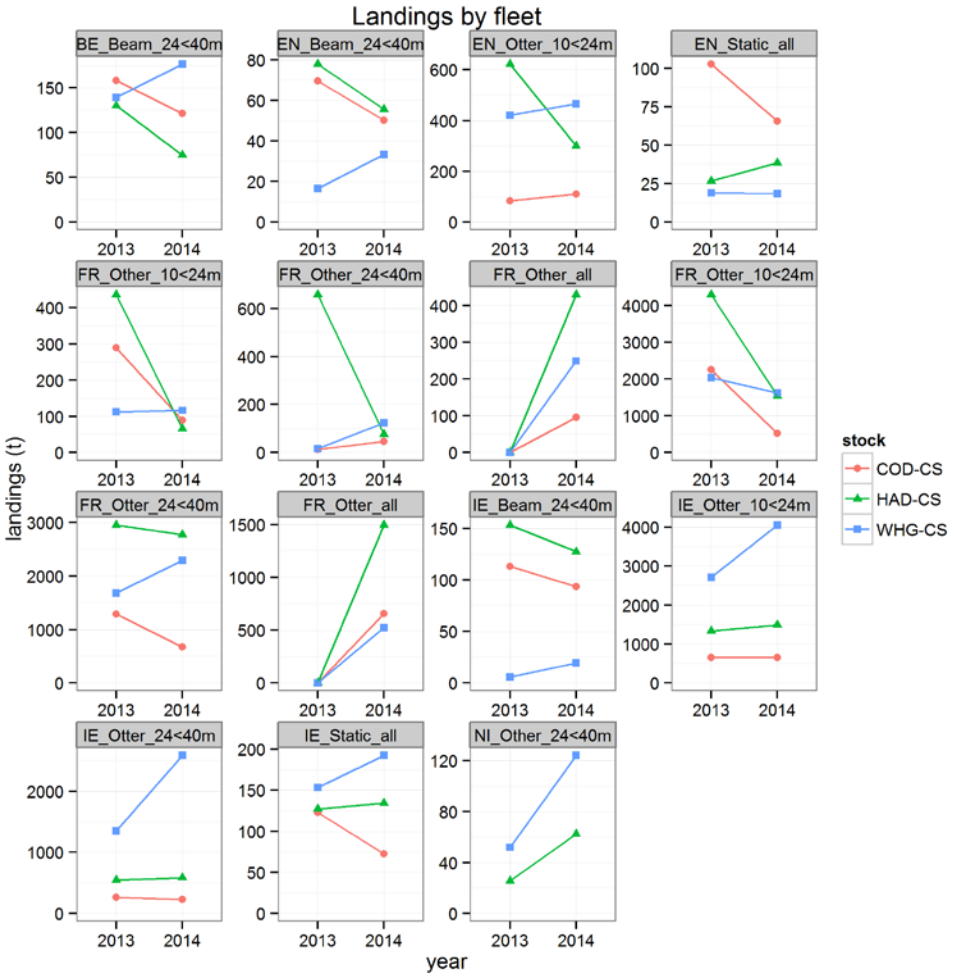


Figure 3.4.3.b. Landings by fleet, stock and year. Note: different scales on the y-axis.

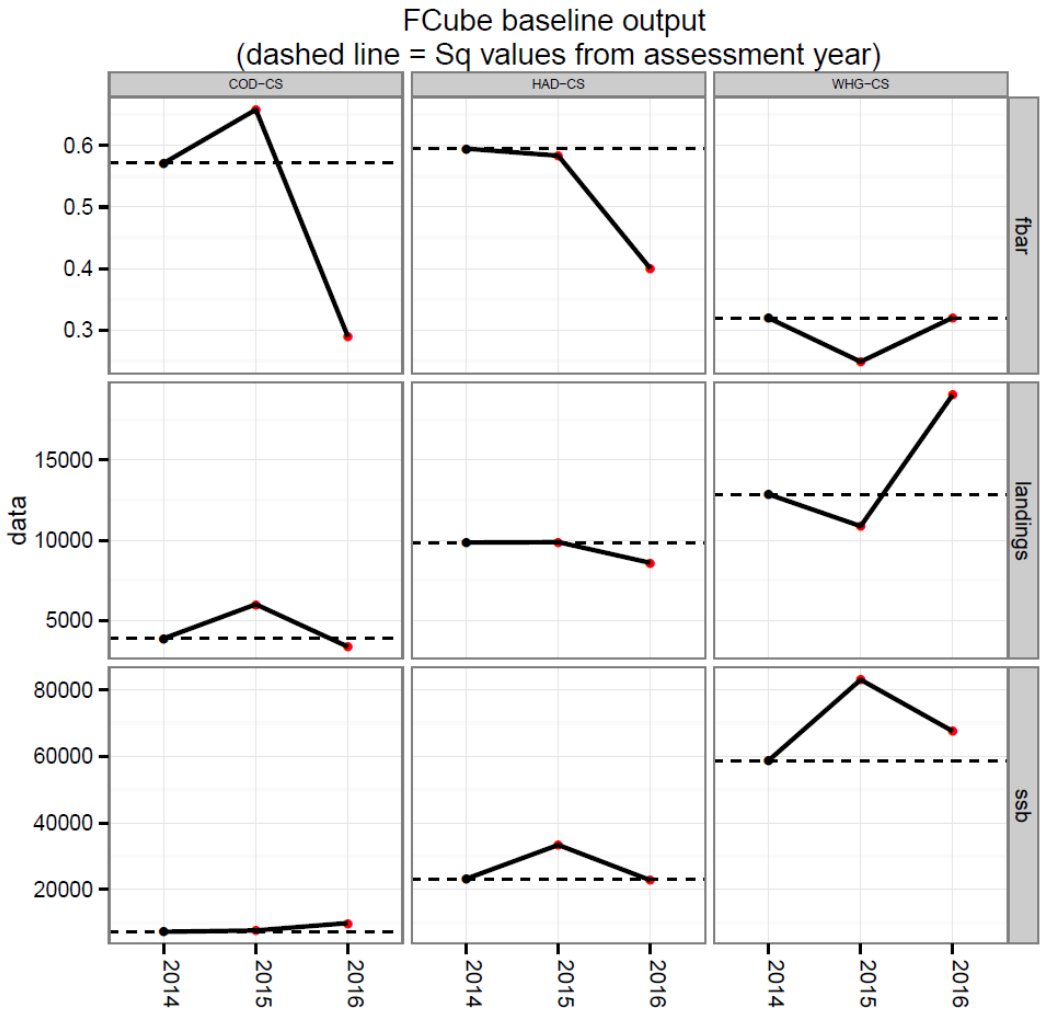


Figure 3.5.2.1.a. Change in Fishing mortality (Fbar), landings (tonnes) and SSB (tonnes) assumed in the intermediate year (2015) and required for the TAC year (2016) under the single stock forecast assumptions consistent with the MSY approach.

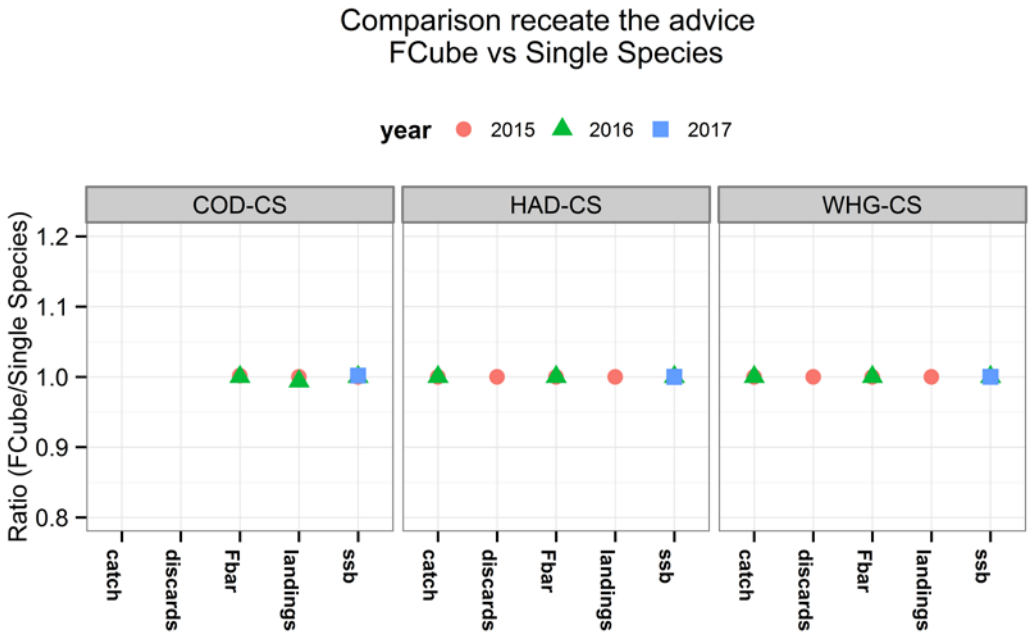


Figure 3.5.2.1.b. Celtic Sea. Difference between Fcube baseline run and Single Species advice for finfish stocks, showing Fbar (2015–2016), landings (2015–2016) and SSB (2016–2017).

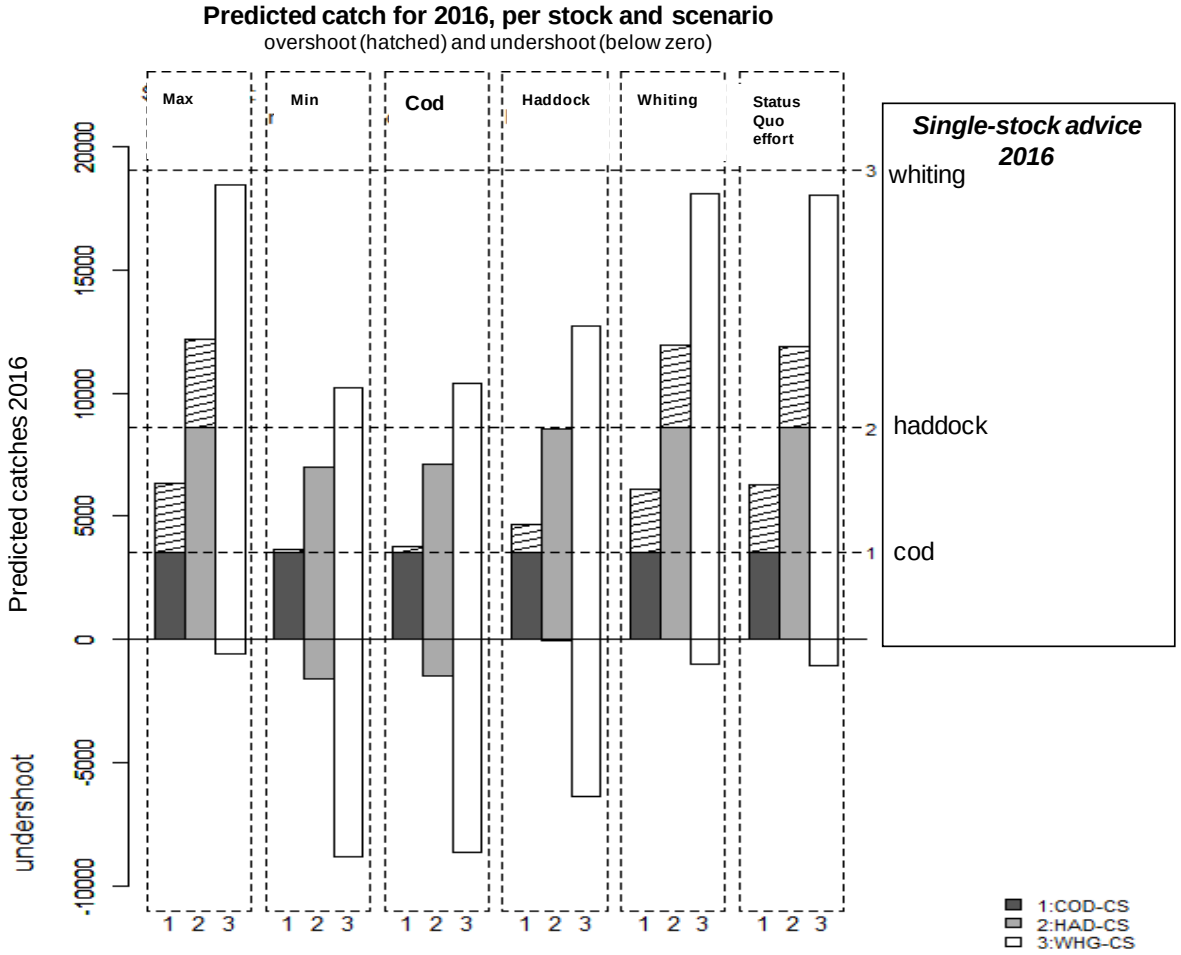


Figure 3.5.2.2.a. Celtic Sea. TAC year results (2016). Fcube estimates of potential landings by stock after applying the *status quo* effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single-stock advice. Bars below 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.

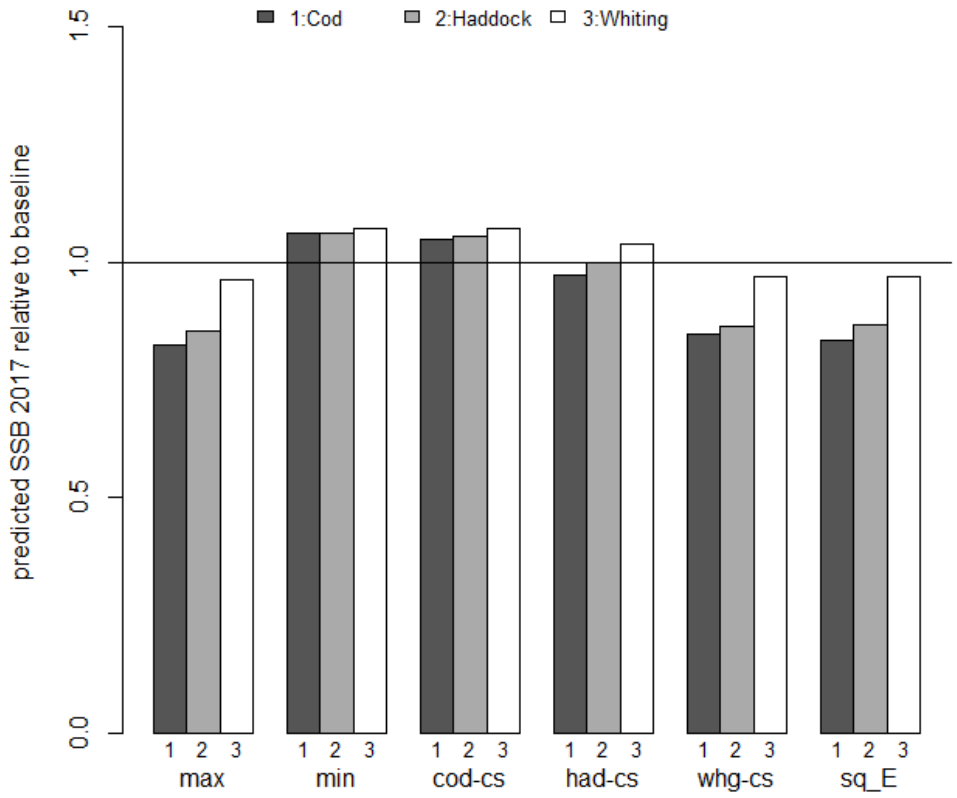


Figure 3.5.2.2.b. Celtic Sea. Estimates of potential SSB at the start of 2017 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2017).

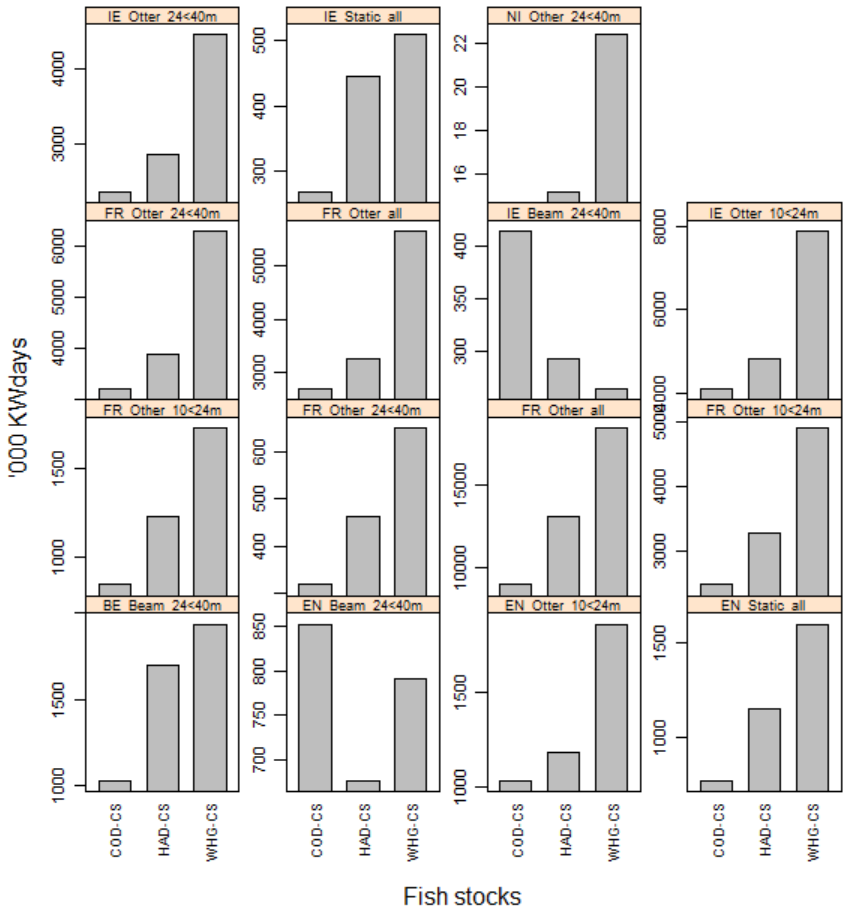


Figure 3.5.2.2.c. Celtic Sea. TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2016 (baseline run).

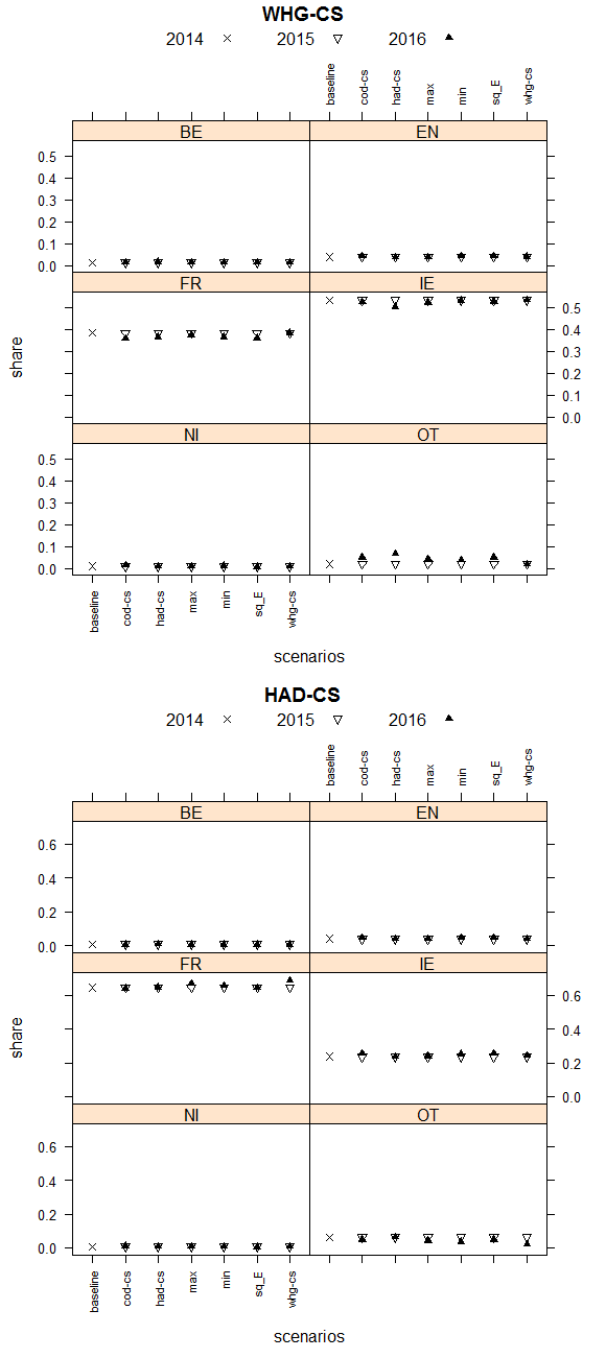


Figure 3.5.2.2.2. Test for relative stability. Changes of relative share of species' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

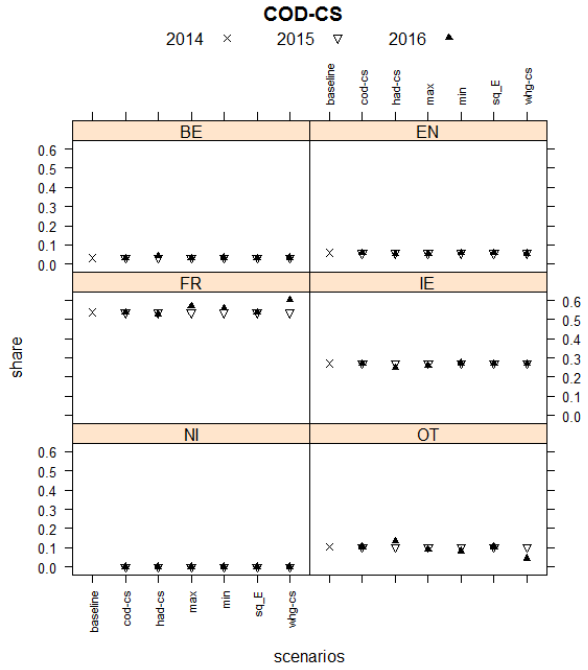


Figure 3.5.2.2.2 (cont). Test for relative stability. Changes of relative share of species' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

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 VIIIc and IXa, and it is applied in both areas with the exception of Gulf of Cadiz. The baselines assigned in 2015 (Council Regulation 2015/104) were based on track record per vessel on years 2012 or 2013.

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) Nº 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. ICES has not evaluated the southern hake management plan under a single-stock perspective nor under an integrated approach.

4.2 Fcube

4.2.1 Software

All analyses were conducted using the FLR framework (Kell *et al.* (2007); 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 VIIIc-IXa	GADGET	GADGET (script: predict.st.sh)
FOUR-SPOT MEGRIM VIIIc-IXa	XSA	MFDP
MEGRIM VIIIc-IXa	XSA	MFDP
WHITE ANGLERFISH VIIIc-IXa	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 2015, single-species ICES advice was given according to a single preferred option; management plan if implemented, MSY approach otherwise. The basis for each single-stock advice was retained in the current mixed-fisheries framework.

In addition to five scenarios considered in the previous analysis (ICES, 2013), a sixth scenario was added to be included 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) **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.

7) **Ef_Mgt**: The effort in métiers using gear controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulation (EC) 2015/104; Annex IIB).

8) **Hake_MP:** The hake TAC is calculated applying the constraint on inter-annual variation in TAC (15%) established by the current hake management plan (see Council Regulation (EC) Nº 2166/2005, Article 7).

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 ICES WGBIE (2015). A number of WGBIE stocks 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 over 16% for hake and 19% for white anglerfish, 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 only provided with official landings, therefore discards and non-reported landings had to be added while during the meeting.

4.3.1.2 Trends and Advice

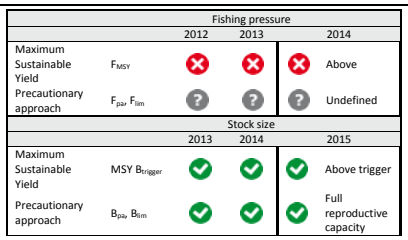
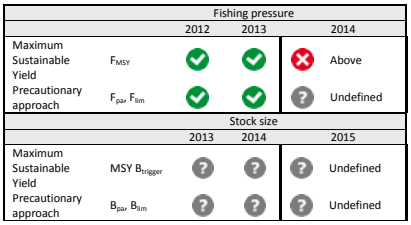
This advice is drafted by the WGBIE-2015 before considerations by ACOM.

Recent trends are described on a stock-by-stock basis in ICES (2015), and latest advice by stock is available on the ICES website. In order to give a global overview of all Iberian demersal stocks at one time, this information is summarized below. It should be noted that although there is only one advice, additional management considerations

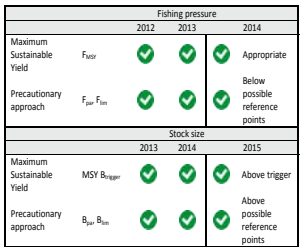
are also listed in the single species advice. Table 4.3.1.2 lists the final advised TACs for 2016 and expected SSBs in 2017.

4.3.1.2.1 Analytical stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Hake	Divisions VIIIc and IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ✗ ✗ ✗ Above Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Unknown Precautionary approach B_{pa}, B_{lim} ? ? ? Above B_{lim}	The spawning-stock biomass (SSB) has increased since 2004 and is well above Blim in 2015. The fishing mortality (F) is well above the FMSY. Recruitment (R) was high in 2005 to 2009, and it is currently close to the historical mean.	ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 6078 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average of the last three years (2012–2014), this implies landings of no more than 5292 tonnes.
Four-spot megrim	Divisions VIIIc and IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ✗ ✗ ✗ Above Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$ ✓ ✓ ✓ Above trigger Precautionary approach B_{pa}, B_{lim} ✓ ✓ ✓ Full reproductive capacity	The spawning stock biomass (SSB) decreased from the late 1980s to a minimum in 2001, but since then SSB has increased and is currently above MSY Btrigger. Fishing mortality (F) declined throughout the whole time-series, but has been increasing in the last two years and is currently above FMSY. Recruitment (R) has been around the average since 2000, with the exception of a record high in 2009 and 2012.	ICES advises on the basis of the MSY approach that catches in 2016 should be no more than 1072 tonnes. If discard rates do not change from the average of the last five years (2010–2014), this implies landings of no more than 841 tonnes. Combined catches of Lepidorhombus boscii and Lepidorhombus whiffiagonis should be no more than 1259 tonnes and landings should be no more than 1013 tonnes in 2016.

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Megrim	Divisions VIIIc and IXa		The spawning stock biomass (SSB) has increased from the minimum observed in 2009, and it is now above MSY Btrigger. Fishing mortality (F) continuously declined until 2010, but it has increased since then and it is now above FMSY. After a period of relatively low recruitment (R), the mean of the last four year classes is close to the long-term average recruitment.	ICES advises on the basis of the MSY approach that catches in 2016 should be no more than 186 tonnes. If discard rates do not change from the average of the last five years (2010–2014), this implies landings of no more than 172 tonnes. Combined catches of Lepidorhombus boscii and Lepidorhombus whiffiagonis should be no more than 1259 tonnes and landings should be no more than 1013 tonnes in 2016.
White anglerfish	Divisions VIIIc and IXa		The spawning-stock biomass (SSB) has been increasing since 1994 and has been high since 2005. Fishing mortality (F) has been close to FMSY since 2010 and in 2014 it is above FMSY. Recruitment (R) has been low in recent years with no evidence of strong year classes since 2001.	ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 1343 tonnes. All catches are assumed to be landed. Combined catches of Lophius piscatorius and Lophius budegassa should be no more than 2413 tonnes in 2016.

4.3.1.2.2 Analytical stocks (not included)

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Black anglerfish	Divisions VIIIc and IXa		Biomass has been increasing since 2000 and is estimated to be above MSY Btrigger over the time-series. Fishing mortality (F) has decreased since 1999 and is estimated to have been below FMSY since 2008.	ICES advises that when the MSY approach is applied, catches in 2016 should be no more than 1070 tonnes. All catches are assumed to be landed. Combined catches of Lophius piscatorius and Lophius budegassa should be no more than 2413 tonnes in 2016.

4.3.1.2.3 Nephrops stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Nephrops	Division VIIIc FU25	Not yet available	Not yet available	Not yet available
Nephrops	Division IXa FU26	Not yet available	Not yet available	Not yet available
Nephrops	Division IXa FU27	Not yet available	Not yet available	Not yet available
Nephrops	Division IXa FU28	Not yet available	Not yet available	Not yet available
Nephrops	Division IXa FU29	Not yet available	Not yet available	Not yet available
Nephrops	Division IXa FU30	Not yet available	Not yet available	Not yet available
Nephrops	Division VIIIc FU31	Not yet available	Not yet available	Not yet available

4.3.1.2.4 Ancillary stocks

SPECIES	AREA	STOCK STATUS	SUMMARY	ADVICE 2016
Seabass	Divisions VIIIc and IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ? ? ? Undefined Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Undefined Precautionary approach B_{pa}, B_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown	The commercial landings in the last two decades have been variable. Recreational catch is unknown but may be significant.	ICES advises than when the precautionary approach is applied, commercial catches should be no more than 598 tonnes in each of the years 2016 and 2017. All commercial catches are assumed to be landed. Recreational catches cannot be quantified; therefore, total catches cannot be calculated.
Plaice	Subarea VIII and Division IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ? ? ? Undefined Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Undefined Precautionary approach B_{pa}, B_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown	Landings have been relatively stable over the time period. The available information is insufficient to evaluate stock trends and exploitation status. Therefore, the status of the plaice in this area is unknown.	ICES advises that when the precautionary approach is applied, wanted catch should be no more than 194 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding total catches.

Pollack	Subarea VIII and Divisio n IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ? ? ? Undefined Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Undefined Precautionary approach B_{pa}, B_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown	The stock status of pollack in this area is unknown.	ICES advises that when the precautionary approach is applied, commercial landings should be no more than 1316 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding catches because the recreational catches and commercial discards cannot be quantified.
Sole	Divisio ns VIIIc and IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ? ? ? Undefined Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Undefined Precautionary approach B_{pa}, B_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown	The available information is insufficient to evaluate stock trends and exploitation status. Therefore, the state of the sole in Divisions VIIIc and IXa is unknown. Landings are mainly taken in Division IXa. Discards are considered negligible.	ICES advises that when the precautionary approach is applied, catches in each of the years 2016 and 2017 should be no more than the catch advised for 2013, 2014 and 2015; this corresponds to a 20% reduction with respect to the average catch of 2009-2011 but, due to uncertainties in the data, the value can not be quantified. Discards are considered to be negligible.
Whitin g	Subarea VIII and Divisio n IXa	Fishing pressure 2012 2013 2014 Maximum Sustainable Yield F_{MSY} ? ? ? Undefined Precautionary approach F_{pa}, F_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown Stock size 2013 2014 2015 Maximum Sustainable Yield MSY $B_{trigger}$? ? ? Undefined Precautionary approach B_{pa}, B_{lim} ? ? ? Undefined Qualitative evaluation -- ? ? ? Unknown	Landings have been relatively stable over the time period. The available information is insufficient to evaluate stock trends and exploitation status. Therefore, the status of the whiting in the Bay of Biscay and Atlantic Iberian waters ecoregion is unknown.	ICES advises that when the precautionary approach is applied, landings should be no more than 1688 tonnes in each of the years 2016 and 2017. ICES cannot quantify the corresponding total catches.

4.4 Fleets and métiers

4.4.1 Catch and effort Data

In 2015, the ICES joined data call has facilitated the uniformity of national commercial data which were required to be uploaded to InterCatch. Besides, the WGMIXFISH specific requirement of métier-based landings and effort files were also included. The data used in the previous Iberian mixed fisheries analysis, developed during 2013 WGMIXFISH, could be compiled with the help of the GEPETO project.

However, the InterCatch data included landings, discard and non-reported landings, while the MIXFISH csv files were provided with only official landings. The non-reported landings, besides the discards of those stocks in whose assessments are included, were added to the MIXFISH csv files during the meeting. The different compilation process as well as the gap between the 2014 InterCatch data and the 2010–2012 GEPETO data made preferable to use only the most recent year in the analysis, so historical comparisons were not carried out.

4.4.2 Definitions of fleets and métiers

The fleet and métier disaggregation available was the current DCF structure for the Spanish fleets, while the Portuguese data were provided re-aggregated into two groups: polyvalent artisanal fleet and bottom otter trawl. The final data provided to the WG contained 11 métiers (Table 4.4.2.a). Regarding fleet segments, size vessels categories were only required for trawl gear: < 10 m, 10 < 24 m, and 24 < 40 m.

As a cross check of the data the total catches across all fleets was compared to the values estimated from the single species stock assessments (Table 4.4.2.b). Some landings may not be allocated to fleets; mainly due to differences between the assessment models used for assess hake and white anglerfish by WGBIE (GADGET and SS3, respectively) and the XSA model replicated by the Fcube model. To address these inconsistencies between fleet data used by WGMIXFISH and stock data, the differences between them were pooled into the "OTH" fleet. Moreover, the original metier composition (Table 4.2.2.a) was split by ICES Divisions obtaining a final set with 16 métiers (Figure 4.4.2).

4.4.3 Trends

Analyses of trends by fleet were not conduced because the MIXFISH csv files, after adding discards and non-reported landings, were only available for year 2014.

4.5 Mixed fisheries forecasts

Discrepancies were found between the FCube baseline runs and the single stock forecasts during the WGMIXFISH-ADVICE May meeting. The discrepancies found in hake and white anglerfish were similar to those obtained in previous analyses (ICES, 2013), and attributed to methodological differences between the length-based assessment models used by WGBIE and the age-based forecast reproduced by WGMIXFISH. However, the discrepancies found in the megrim and four-pot megrim, which are assessed by applying the XSA model, needed a more detailed exploration after the WGMIXFISH-ADVICE meeting. Once the mistake occurred during the WGBIE was identified, the corrected single-stock forecasts were presented to ADGBIE and the required stock files could be updated to run new mixed-fisheries forecasts, which were carried out as inter-seasonal work between the WGMIXFISH-ADVICE and WGMIXFISH-METHODS meetings.

4.5.1 Description of scenarios

4.5.1.1 Baseline Runs

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

9) reproduce as closely as possible the single species advice produced by ACOM, and

10) 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 (LTMP or MSY approach).

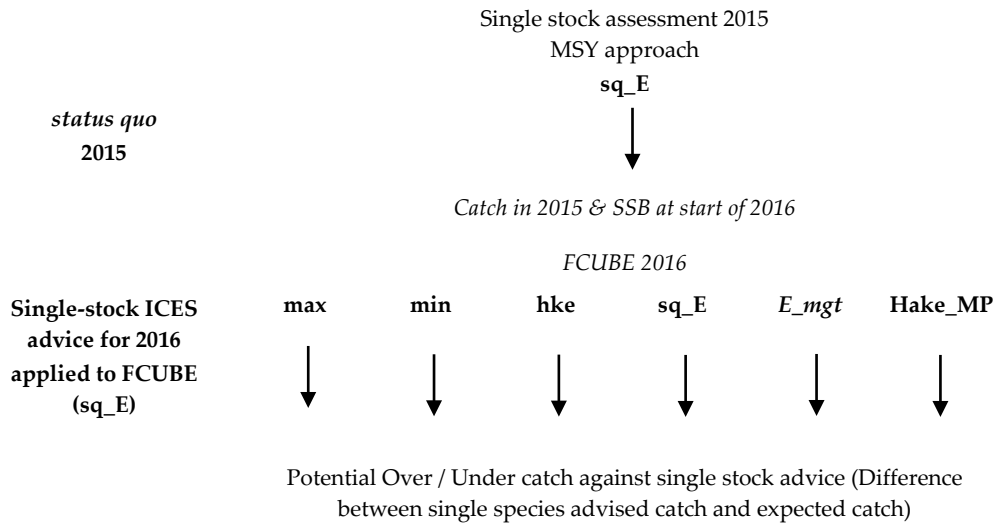
Apart from the differences occurred in the hake and white anglerfish forecasts due to methodological issues, the discrepancies found in megrim and four-spot megrim forecasts allow to detect a small mistake occurred during the WGBIE work, which was solved before the ADGBIE. Thus, this setback supports the usefulness of the WMIXFISH baseline runs as a quality control check on the WGBIE projections.

4.5.1.2 Mixed fisheries runs

The mixed fishery analysis used a status quo effort assumption for the intermediate year (2015), with the Fcube scenarios used for the TAC year (2016). 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.

This year, the projections were run assuming a full and perfect implementation of a discard ban in 2016 (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 2015 (ICES, 2015) is based on the maximum sustainable yield (MSY) approach, except for megrim whose advice is derived from the four-spot megrim management. 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

High discrepancies (16%) 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, 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).

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

High discrepancies (19%) 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) in order to solve the growth uncertainties detected in the previous age-based model. Assessment outputs disaggregated by age need to be specifically required to the stock coordinator. This transformation may explain the discrepancies obtained.

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 2016 is presented in Table 4.5.2.2 and Figures 4.5.2.2.a to 4.5.2.2.c. The results for 2016 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 (Table 4.5.2.2).

The "**max**" scenario demonstrates the upper bound of potential fleet effort and stock catches. However, through assuming that all fleets continue fishing until all their stock shares are exhausted irrespective of the economic viability of such actions, this scenario is generally considered with low plausibility. However, in this case the results were very similar to those provided by the "sq_E" scenario (effort equal to 2014 effort), probably indicating that the fishery is close to the maximum of its activity.

ICES single-stock advice provides TACs expected to meet single stock FMSY. 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 by 67% of its 2014 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.

Beside the "max" and "min" scenarios, which are shown to bound the results rather than provide realistic levels of catches in 2016, four intermediate, more likely, scenarios were also considered taking into the current management measures in place. The "**hake**" scenario gives a result very similar to 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 lost of fishing opportunities for other stocks in a mixed-fisheries context. In this scenario it is assumed that effort reductions in fleets (to achieve new partial Fs) apply equally to all fleets with hake catch. With the exception of the gillnet métier called "*rasco*" which is directed exclusively to white anglerfish, hake is a species caught by all metiers and so all fleets are limited by this stock. As a result, effort reductions resulting from management of hake also affect the ability to exploit the other stocks.

The "**sq_E**" scenario provides even higher catch possibilities for hake than the "max" scenario. This potentially indicates that the fishery is close to the maximum of its activity, particularly in terms of exploitation of hake.

The "**Ef_Mgt**" scenario gives the expected outcome if the nominal effort reductions stipulated in the southern hake effort management plan was translated in full into actual effort cuts and if there existed a 1:1 relationship between fleet effort and mean F. A 10% effort reduction is set in 2015 (Council Regulation (EU) 2015/104; Annex IIB) compared to the 2014 effort (Council Regulation (EU) No 43/2014; Annex IIB) for determined category of vessels. In the absence of official data detailing the number of vessels affected or excluded from the effort reduction, a general assumption was made by applying the established 10% effort reduction to all those metiers targeting hake. The results of this scenario provide similar hake catches than the "max" scenario, but smaller catches for the remaining stocks.

The "**Hake_MP**" scenario gives the expected outcome if the constraint on inter-annual variation in TAC (15%) established by the current hake management plan was applied, while the fleet dynamics is set as in the "hke" scenario. The results of the "Hake_MP" scenario provides lower catches than the "max" and "sq_E" scenarios for all stocks.

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 2014.

In previous analyses, 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 hake, and to a lesser extent white anglerfish, in the "max" scenario. This year, as total catches are used rather than landings, relative stability can suffer some distortions, as the proportion of catches does not reflect the proportion of landings since discards rates differ across fleets (Figures 2.5.2.2.2.a to 2.5.2.2.2.d). This illustrates some of issues that will arise with the implementation of the landings obligation.

Table 4.3.1.2. Iberian waters: Summary of the 2016 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 2016	F 2016	SSB 2017	Rational
Hake VIIIc-IXa	6078 t	0.24	29280 t	MSY approach
Four-spot megrim VIIIc-IXa	1072 t	0.17	6918 t	MSY approach
Megrim VIIIc-IXa	186 t	0.15	1051 t	Four-spot megrim MSY approach
White anglerfish VIIIc-IXa	1343 t	0.19	7677 t	MSY approach

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

ACRONYM	DEFINITION	DESCRIPTION
GNS_DEF_>=100_0_0	Set gillnet targeting demersal fish with mesh sizes larger than 100 mm	Set gillnet ("rasco") targeting anglerfishes (mainly white anglerfish) in ICES Division VIIIc with mesh size of 280 mm
GNS_DEF_60-79_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 60–80 mm	Small set gillnet targeting to 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 80–100 mm	Set gillnet ("volanta") targeting hake with nets of 90 mm mesh size in north-western Spanish waters
GTR_DEF_60-79_0_0	Trammel net targeting demersal fish with mesh sizes within the range 60–80 mm	Trammel net targeting a variety of demersal species in north-western Spanish waters
LLS_DEF_0_0_0	Set longline targeting demersal fish	Set longline targeting a variety of demersal fish in Spanish Iberian waters
MIX_polyvalent	-----	Portuguese polyvalent artisanal fleet (only the fraction of this fleet with catches from stocks included in the analysis was considered)
OTB	----	Portuguese bottom otter trawl

ACRONYM	DEFINITION	DESCRIPTION
OTB_DEF_>=55_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 55 mm	Bottom otter trawl targeting hake, anglerfish, megrim and horse mackerel using "baca" nets of 70 mm mesh size in Divisions VIIIc and IXa
OTB_ MCD_>=55_0_0	Bottom otter trawl targeting mixed crustaceans and demersal fish using mesh sizes larger than 55 mm	Bottom otter trawl targeting fish (hake…) and crustaceans (rose shrimp and Norway lobster) using nets of 55 mm mesh size in south-western Iberian waters (Gulf of Cadiz and Southern Portuguese waters)
OTB_MPD_>=55_0_0	Bottom otter trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	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 55-70 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 higher than the information used by WGBIE.

YEAR	STOCK	WGBIE	WGMIXFISH	DIFFERENCE	RATIO
2014	HKE	12867	14613	1745	0.88
2014	LDB	1947	1942	-4	1.00
2014	MEG	402	399	-3	1.01
2014	MON	1561	2002	441	0.78

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

Management plan		HKE	LDB	MEG	MON
2015	**Fbar**	0.73	0.30	0.27	0.21
	FmultVsF14	1.08	0.77	0.74	0.82
	Landings	13095	1788	334	1224
	SSB	22611	6554	1090	5193
2016	**Fbar**	0.24	0.17	0.15	0.19
	FmultVsF14	0.36	0.43	0.42	0.76
	Landings	4758	1057	186	1108
	SSB	19648	6261	986	5222
2017	**SSB**	29113	6663	1037	5404

Table 4.5.2.1.b. Iberian waters: Comparison between baseline run and ICES advice. Figures for 2015 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
2015	Landings Baseline	13095	1788	334	1224
	Landings ICES	15586	1799	334	1508
	% difference	-16%	0%	0%	-19%
2016	Landings Baseline	4758	1057	186	1108
	Landings ICES	6078	1072	186	1343
	% difference	-17%	0%	0%	-17%

Table 4.5.2.2.: Results of running Fcube scenarios on the TAC year (2016). Comparison of the singe-stock ICES advice and potential landings in the various Fcube scenarios.

	Single-stock catches advice 2016		Catches per mixed-fisheries scenario 2016 relative to the single-stock catch advice					
Stock	WGBIE	WGMIXFISH	"Max"	"Min"	"Hke"	"Sq_E"	"Ef_Mgt"	"Hake_MP"
Hake VIIIc-IXa	6078	4758	2.25	1.01	1.01	2.44	2.27	1.94
Four-spot megrim VIIIc-IXa	1072	1057	2.57	0.70	0.71	1.85	1.59	1.42
Megrim VIIIc-IXa	186	186	2.45	0.71	0.72	1.81	1.58	1.41
White anglerfish VIIIc-IXa	1343	1108	1.32	0.61	0.74	1.42	1.35	1.15

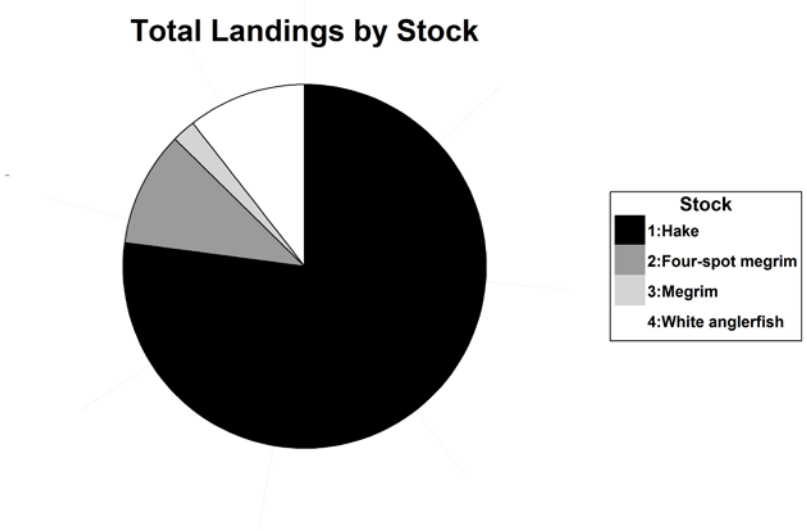


Figure 4.4.1. Iberian waters: Distribution of landings of those stocks included in the mixed fisheries projections.

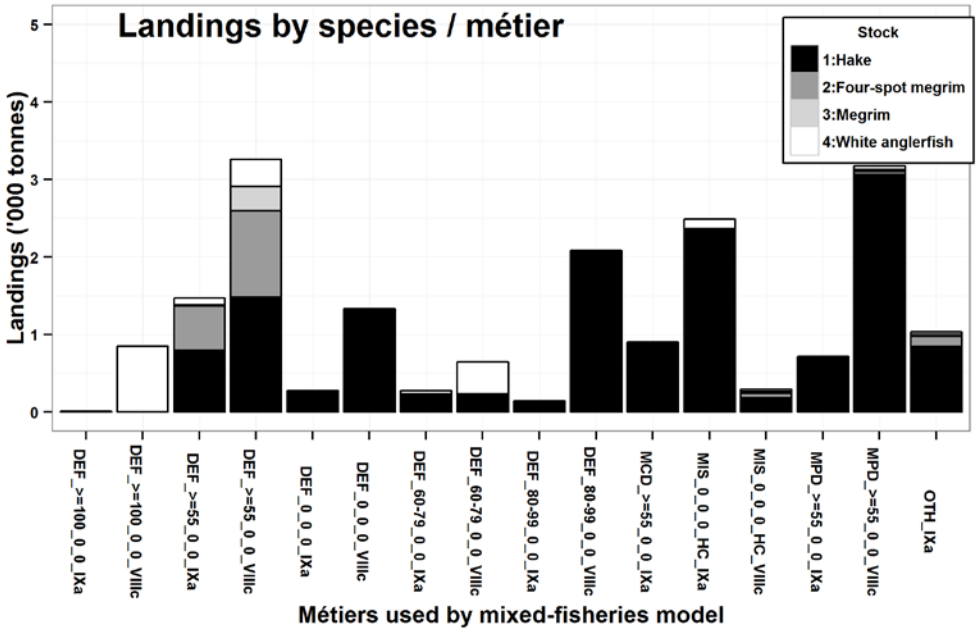


Figure 4.4.2. Iberian waters: Landings distribution of species by métier. Note: The "other" (OTH) displayed here is a landings without corresponding effort.

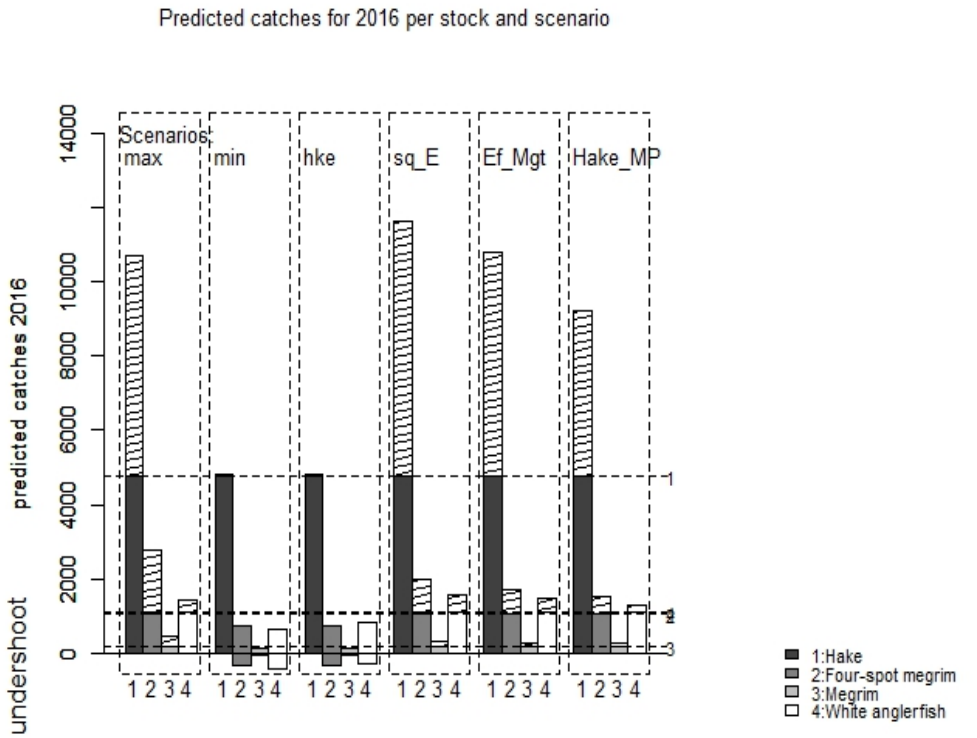


Figure 4.5.2.2.a. Iberian waters mixed-fisheries forecasts: TAC year results (2016). Fcube estimates of potential catches by stock after applying the status quo effort scenario to all stocks in the intermediate year followed by the Fcube scenarios. Horizontal lines correspond to the TAC set by the single-stock 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.

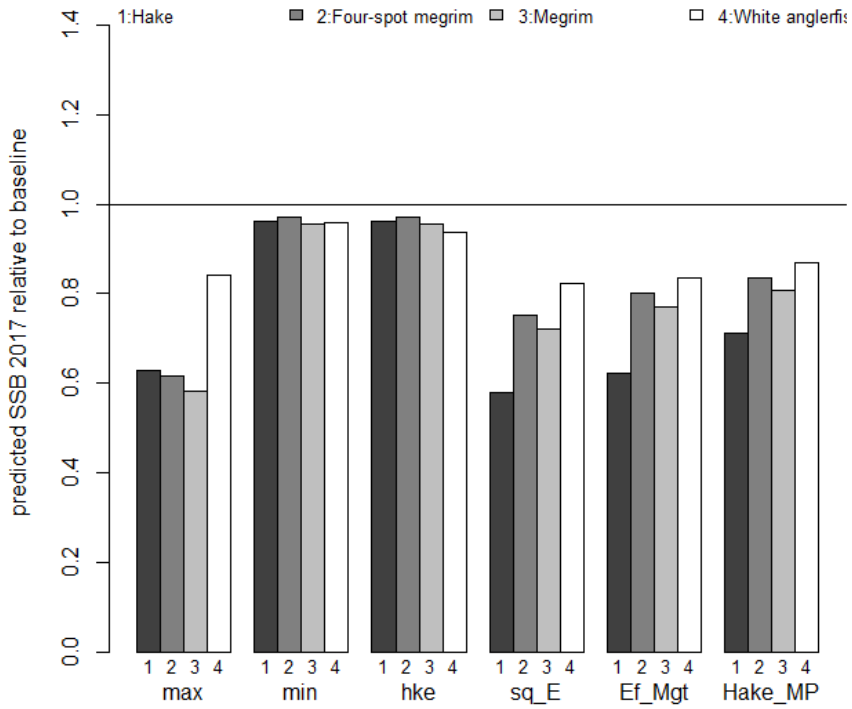


Figure 4.5.2.2.b. Iberian waters mixed-fisheries forecasts: Estimates of potential SSB at the start of 2017 by stock after applying the mixed fisheries scenarios, expressed as a ratio to the single species advice forecast. Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2017).

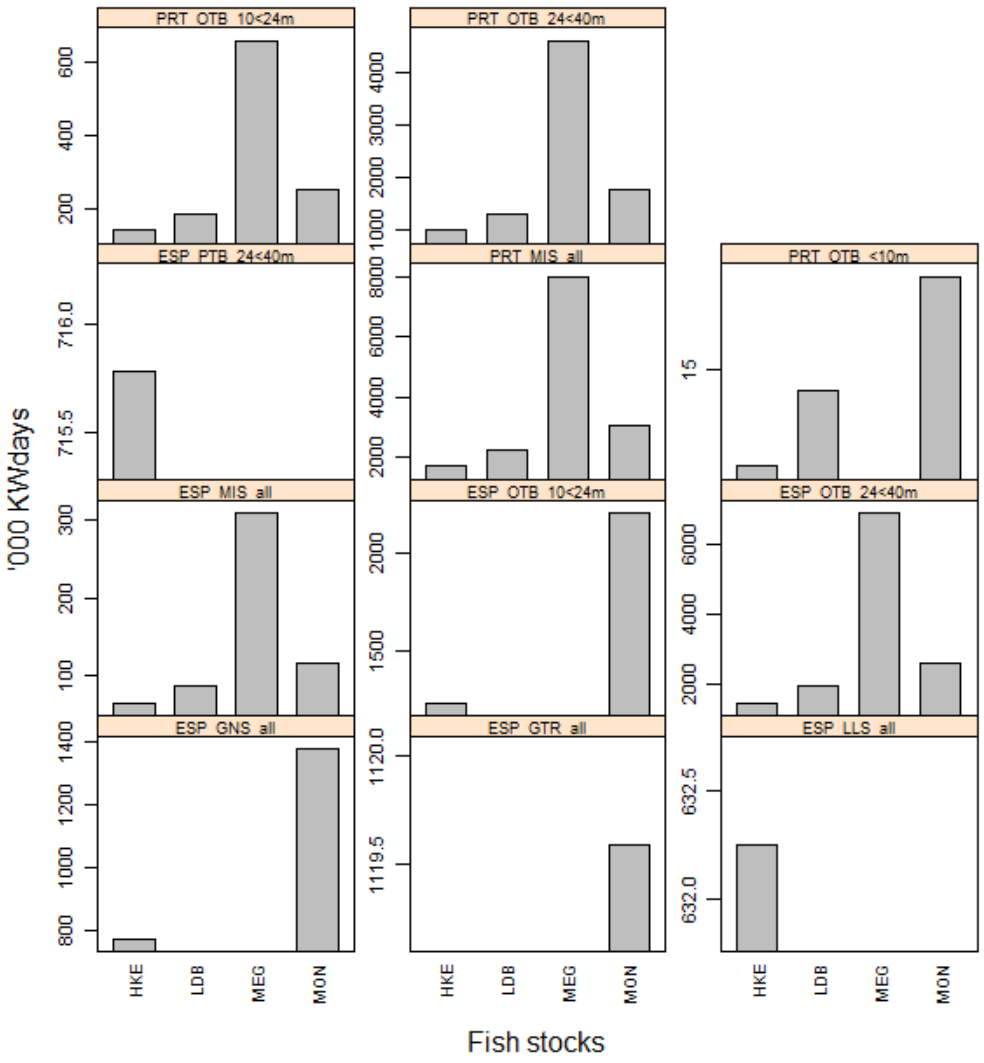


Figure 4.5.2.2.c. Iberian waters mixed-fisheries forecasts: TAC year results (2016). Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2016 (baseline run).

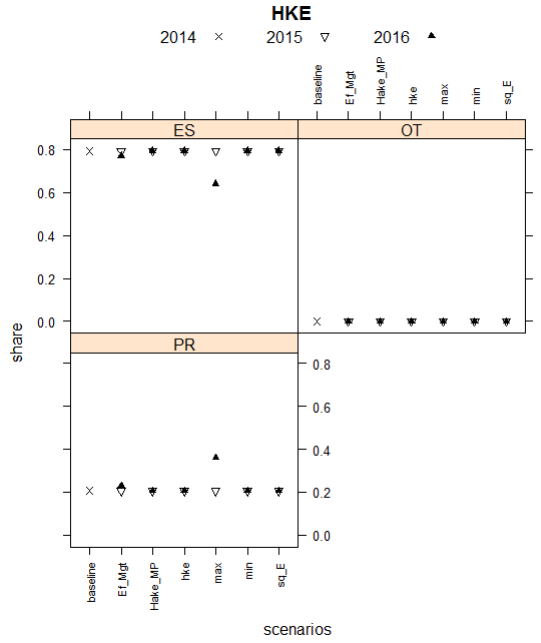


Figure 4.5.2.2.2.a. Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of hake' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

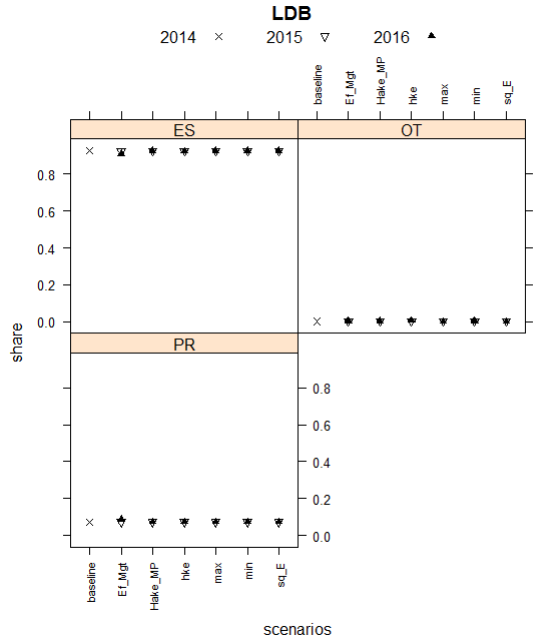


Figure 4.5.2.2.2.b. Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of four-spot megrim' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

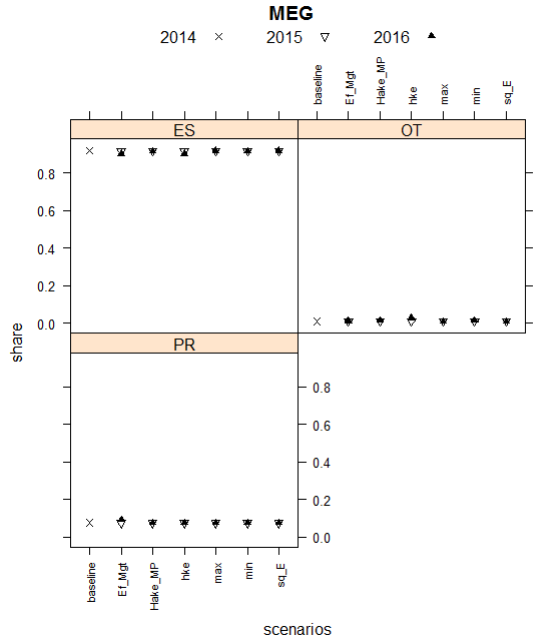


Figure 4.5.2.2.2.c. Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of megrim' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

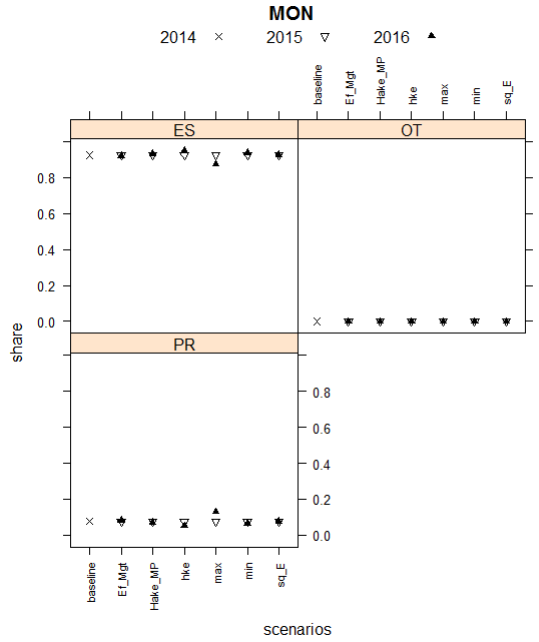


Figure 4.5.2.2.2.d. Iberian waters mixed-fisheries forecasts: Test for relative stability. Changes of relative share of white anglerfish' landings by country in 2015 and 2016 compared to the 2014 share, for the 'baseline' and 6 Fcube scenarios.

5 Additional issues

5.1 Introduction of the EU landings obligation

The EU landings obligation for demersal species is due to be implemented from 2016 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, this year 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, 2016) 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). While the actual proposed implementation of is yet to be decided, and it is unlikely a full discard ban will be in place from 2016, 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 behavioural 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 Appointment of new WGMIXFISH–ADVICE and WGMIXFISH–METHODS chair

Due to a change in work focus of the current chair there is a need to appoint a new chair going forward. After discussion within the group, it was unanimously agreed to support Dr Youen Vermard of France as the next chair of the WGMIXFISH-ADVICE and WGMIXFISH-METH groups.

5.3 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 aggressing 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

2014/2/ACOM23 The Working Group on Mixed Fisheries Advice Methodology (WGMIXFISH-METHODS), chaired by Youen Vermard, France, will meet in Copenhagen, 5—9 October 2015 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 taking account of uncertainties;
    2) Incorporation of advice on protected, endangered and threatened (PET) species into mixed fisheries advice;
    3) Incorporation of Fmsy 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,
    4) Application of methodology to other ICES regions, fisheries and stocks.

b) Undertake a Principle Components Analysis (PCA) on the MIXFISH métier data used in North Sea mixed fishery forecasts to inform a minimum fleet aggregation for use in ecosystem models

WGMIXFISH-METH will report by 23 November 2015 for the attention of ACOM.

6 Conclusions and recommendations

WGMIXFISH-ADVICE has produced a draft North Sea Mixed Fisheries advice sheet and a draft Celtic Sea Mixed Fisheries advice sheet for use by ACOM. In addition, much progress was made in developing an Iberian Waters 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.

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 (no such problems were encountered for the Celtic Sea, but it is more likely as further stocks are incorporated). 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* in the Celtic Sea) 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 is 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.

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 is 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 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.

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Annex 1: List of participants

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Annex 2: Data issues for specific nations

Belgium

The Belgium landings and effort data were compiled according to the specification of the data request. Discard information was only available for the main métiers (Beam trawls) and since 2004.

Denmark

Landings and effort data for 2014 were compiled according to the specification of the data request, and appended to the dataset from last year. It was only possible to attach discard information to some métiers.

France

Landings and effort data for 2014 were compiled according to the specification of the data request, and appended to the dataset from last year. It was only possible to attach discard information to some métiers. All the time-series could not be resubmitted to fulfil the data request specification. However, the different fisheries (saithe fishery vs. fishery on cod and plaice) were taken into account using the vessel length class already available in previous data submission. Data for 2009 were not available for the meeting.

Germany

Landings and effort data for 2014 were compiled according to the specification of the data request, and appended to the dataset from last year. It was only possible to attach discard information to some métiers. With otter trawls > = 100 mm different kinds of fisheries are conducted (saithe fishery vs. fishery on cod and plaice) that cannot be fully differentiated by the current DCF métiers and German sampling scheme. Value information was available for 2010–2013 data only.

Ireland

Landings and effort data for 2014 were provided to the group as requested. Ireland submitted data through InterCatch at DCF level 4 (gear only) not DCF level 5 as used by WGMIXFISH. As such, no distinction between discard rates for large or small mesh fisheries could be made by WGMIXFISH.

The Netherlands

Landings and effort data for 2014 were compiled according to the specification of the data request, and appended to the dataset from last year. It was only possible to attach discard information to some métiers.

Norway

From 2011 a new electronic logbook has been implemented in Norwegian fisheries for all vessels with total length over 15 m using a new database standard. Vessels between 12 and 15 m total length may submit daily electronic logbooks if they have the capability to do so; vessels under 12 m in length are not required to submit logbooks. Vessels are again required to submit information on mesh size in the logbooks; it was only 2012 that this requirement was relaxed.

Portugal

Data were provided for 2012-2014 according to the data call; however data were given aggregated for trawl (OTB) and artisanal (MIS_MIS_0_0_0) fleets. A metier disaggregation would be more appropriate to develop a mixed-fisheries analysis.

Spain

Data were provided for 2014 according to the data call, for Iberian (ICES Divisions VIIIc and IXa) and Western waters (Subareas VI, VII and Divisions VIIIabd). The technical disaggregation followed the DCF Level 6, providing data for 14 Spanish métiers. Discards data were also compiled for those stocks including discards in the assessment. In addition to the files specifically requested by the WGMIXFISH, the data compilation for Iberian waters was greatly facilitated by the extensive use of InterCatch which was promoted by the joined Data call this year.

UK (England, Wales and Northern Ireland)

Data were provided for England, Wales and Northern Ireland for 2014 according to the data call. Discard data were only available for some métiers. Not all length classes of vessels are routinely sampled for discards, but the discard data were applied to all vessel length categories irrespective of this. The dataset includes some vessels from UK (Northern Ireland) and from Guernsey that fish in the North Sea and/or Eastern Channel. These vessels are lumped in with the English fleet for analysis. Fully Documented Fishery (FDF) vessels were recorded as a separate fleet both for landings and effort.

Scotland

Landings and effort data were compiled according to the specification of the data request. It was only possible to attach discard information to some métiers; also the design of the Scottish discard observer scheme changed in 2009 and aggregation strata were revised again for 2010 data. For data between 2003 and 2008 the Scottish discard observer scheme was designed to achieve a reasonable coverage of vessels in each of the following categories

- MTR: Motor trawl (bottom trawls, boat length > = 27.432 m, targeting demersal species)
- LTR: Light trawl (bottom trawls, boat length < 27.432 m, targeting demersal species)
- PTR: Pair trawl (all pair trawls targeting demersal species)
- SEN: Seine nets (single and pair)
- NTR: *Nephrops* trawls (all trawls targeting *Nephrops*)

Where the gear categories for records in the landings dataset could be mapped to one of the above categories a discard value was assigned according to the discard ratio of that category. Therefore records mapped to these categories always receive the same ratio of discards to landings.

Vessels with OTTER and PEL_TRAWL gear and in the length categories > 24 to 40 m and > 40 m were mapped to the MTR category. However, as for STECF effort calculations all records with OTTER gear and with mesh between 70 and 100 mm are mapped to NTR.

For 2009 data discard fractions were available for the two categories

- DEF: Demersal otter, demersal seine and beam trawls targeting demersal fish
- CRU: Demersal otter, demersal seine and beam trawls targeting crustaceans

Vessels with PEL_TRAWL gear and with OTTER gear with mesh > 100 mm were mapped to the DEF category. Vessels with OTTER gear with mesh < 100 mm were mapped to the CRU category. The Scottish fleet consists of few beam trawlers and the discard rates in the DEF and CRU categories reflect those from otter and demersal seine gears. Discards were therefore not attached to beam trawl landings.

For 2010 and 2011 data discard fractions were available for the two categories

- TR1: Demersal otter and demersal seine gears with mesh > = 100 mm
- TR2: Demersal otter and demersal seine gears with mesh > = 70 and < 100 mm

Again discards were not attached to beam trawl landings.

For 2012 data fully documented fishery (FDF) fleet data were raised separately.

The sampling of vessels < 10 m is very limited and it is considered unreasonable to assume they have the same discarding patterns as larger boats. Scotland does not provide discard estimates for vessels < 10 m to STECF. Discard estimates are therefore not estimated for vessels in the < 12 m category (2003–2010) or < 10 m (2011 onwards).

Annex 3: North Sea stock-based management plans

Cod in IIIa – IV – VIId (Norway-EU management plan and EU management plan – EC 1342/2008)

EU Norway management plan

In 2008 the EU and Norway renewed their initial agreement from 2004 and agreed to implement a long-term management plan for the cod stock, which is consistent with the precautionary approach and is intended to provide for sustainable fisheries and high yield.

Transitional arrangement

F will be reduced as follows: 75% of F in 2008 for the TACs in 2009, 65% of F in 2008 for the TACs in 2010, and applying successive decrements of 10% for the following years.

The transitional phase ends as from the first year in which the long-term management arrangement (paragraphs 3–5) leads to a higher TAC than the transitional arrangement.

Long-term management

1. If the size of the stock on 1 January of the year prior to the year of application of the TACs is:
    a. Above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0.4 on appropriate age groups;
    b. Between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula:

        0.4 - (0.2 * (Precautionary spawning biomass level - spawning biomass) / (Precautionary spawning biomass level - minimum spawning biomass level))

    c. At or below the limit spawning biomass level, the TAC shall not exceed a level corresponding to a fishing mortality rate of 0.2 on appropriate age groups.
2. Notwithstanding paragraphs 2 and 3, the TAC for 2010 and subsequent years shall not be set at a level that is more than 20% below or above the TACs established in the previous year.
3. Where the stock has been exploited at a fishing mortality rate close to 0.4 during three successive years, the parameters of this plan shall be reviewed on the basis of advice from ICES in order to ensure exploitation at maximum sustainable yield.
4. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are advised by ICES as corresponding to the fishing mortality rates consistent with the management plan:
    a. A quantity of fish equivalent to the expected discards of cod from the stock concerned;
    b. A quantity corresponding to other relevant sources of cod mortality.

5. The Parties agree to adopt values for the minimum spawning biomass level (70 000 tonnes), the precautionary biomass level (150 000 tonnes) and to review these quantities as appropriate in the light of ICES advice.

Procedure for setting TACs in data-poor circumstances

6. If, due to a lack of sufficiently precise and representative information, it is not possible to implement the provisions in paragraphs 3–6, the TAC will be set according to the following procedure.

    a. If the scientific advice recommends that the catches of cod should be reduced to the lowest possible level the TAC shall be reduced by 25% with respect to the TAC for the preceding year;

    b. In all other cases the TAC shall be reduced by 15% with respect to the TAC for the previous year, unless the scientific advice recommends otherwise.

This plan shall be subject to triennial review, the first of which will take place before 31 December 2011. It enters into force on 1 January 2009.

The main changes between this and the plan of 2004 are the phasing (transitional and long-term phase) and the inclusion of an F reduction fraction.

In December 2008 the European Council agreed on a new cod management plan implementing the new system of effort management and a target fishing mortality of 0.4 (EC 1342/2008). The HCR for setting TAC for the North Sea cod stock are as follows:

EU management plan

Article 7 1.(a) and 1.(b) are required for interpretation of Article 8.

Article 7: Procedure for setting TACs for cod stocks in the Kattegat the west of Scotland and the Irish Sea

1. *Each year, the Council shall decide on the TAC for the following year for each of the cod stocks in the Kattegat, the west of Scotland and the Irish Sea. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are forecast by STECF as corresponding to the fishing mortality rates referred to in paragraphs 2 and 3:*

(a) a quantity of fish equivalent to the expected discards of cod from the stock concerned;

(b) as appropriate a quantity corresponding to other sources of cod mortality caused by fishing to be fixed on the basis of a proposal from the Commission. […]

Article 8: Procedure for setting TACs for the cod stock in the North Sea

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).

2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.

3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75% for the TACs in 2009, 65% for the TACs in 2010, and applying successive decrements of 10% for the following years.

4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:

(a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;

*(b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: 0,4 – (0,2 * (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))*

(c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.

5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20% below or above the TACs established in the previous year.

6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.

Article 9: Procedure for setting TACs in poor data conditions

Where, due to lack of sufficiently accurate and representative information, STECF is not able to give advice allowing the Council to set the TACs in accordance with Articles 7 or 8, the Council shall decide as follows:

(a) where STECF advises that the catches of cod should be reduced to the lowest possible level, the TACs shall be set according to a 25% reduction compared to the TAC in the previous year;

(b) in all other cases the TACs shall be set according to a 15% reduction compared to the TAC in the previous year, unless STECF advises that this is not appropriate.

Article 10: Adaptation of measures

1. When the target fishing mortality rate in Article 5(2) has been reached or in the event that STECF advises that this target, or the minimum and precautionary spawning biomass levels in Article 6 or the levels of fishing mortality rates given in Article 7(2) are no longer appropriate in order to maintain a low risk of stock depletion and a maximum sustainable yield, the Council shall decide on new values for these levels.

2. In the event that STECF advises that any of the cod stocks is failing to recover properly, the Council shall take a decision which:

(a) sets the TAC for the relevant stock at a level lower than that provided for in Articles 7, 8 and 9;

(b) sets the maximum allowable fishing effort at a level lower than that provided for in Article 12;

(c) establishes associated conditions as appropriate.

Haddock in IIIa – IV (EU and Norway management plan)

"The plan consists of the following elements:

1. *Every effort shall be made to maintain a minimum level of Spawning-stock biomass greater than 100 000 tonnes (Blim).*
2. *For 2009 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140 000 tonnes (Bpa).*
3. *Where the rule in paragraph 2 would lead to a TAC, which deviates by more than 15% from the TAC of the preceding year, the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*
4. *Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to 0.3–0.2*(Bpa-SSB)/(Bpa-Blim). This consideration overrides paragraph 3.*
5. *Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.*
6. *In the event that ICES advises that changes are required to the precautionary reference points Bpa (140 000 tonnes) or Blim, (100 000 tonnes) the Parties shall meet to review paragraphs 1–5.*
7. *In order to reduce discarding and to increase the spawning-stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*
8. *No later than 31 December 2010, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.*
9. *This arrangement enters into force on 1 January 2009."*

Saithe in IIIa – IV – VI (EU and Norway management plan)

In 2008 EU and Norway renewed the existing agreement on *"a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements.*

1. *Every effort shall be made to maintain a minimum level of Spawning-stock biomass (SSB) greater than 106 000 tonnes (Blim).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes, the TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30–0.20*(200 000-SSB)/94 000.*

4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall fix a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2012.*
8. *This arrangement enters into force on 1 January 2009."*

Plaice in IV (Multiannual plan for sole and plaice in the North Sea EC 676/2007)

Extract from Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea:

Article 2 Safe biological limits

1. For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:

(a) the spawning biomass of the stock of plaice exceeds 230 000 tonnes;

(b) the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;

(c) the spawning biomass of the stock of sole exceeds 35 000 tonnes;

(d) the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

2. If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1

Article 3 Objectives of the multiannual plan in the first stage

1. The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.

2. The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10% each year, with a maximum TAC variation of 15% per year until safe biological limits are reached for both stocks.

Article 4 Objectives of the multiannual plan in the second stage

1. The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.

2. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.

3. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.

Article 5 Transitional arrangements

1. When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles 4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.

Article 7 Procedure for setting the TAC for plaice:

1. *The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:*
    - *(a) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;*
    - *(b) that TAC the application of which will result in the level of fishing mortality rate of 0.3 on ages two to six years in its year of application.*
2. *Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.*
3. *Where application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.*

Sole in IV (Multiannual plan for sole and plaice in the North Sea EC 676/2007)

Extract from Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea

Article 2 Safe biological limits

1. For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:

(a) the spawning biomass of the stock of plaice exceeds 230 000 tonnes;

(b) the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;

(c) the spawning biomass of the stock of sole exceeds 35 000 tonnes;

(d) the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

2. If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1.

Article 3 Objectives of the multiannual plan in the first stage

1. The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.

2. The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10% each year, with a maximum TAC variation of 15% per year until safe biological limits are reached for both stocks.

Article 4 Objectives of the multiannual plan in the second stage

1. The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.

2. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.

3. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.

Article 5 Transitional arrangements

1. When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles 4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.

Article 8 Procedure for setting the TAC for sole:

1) The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

   (a) that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;

   (b) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

2) Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

3) Where the application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

Whiting in IV – VIId (EU and Norway interim management plan)

The TAC for whiting for 2011 will be fixed by applying an interim management plan consisting of the following elements:

1. For 2011 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups.

2. Where the rule in paragraph 1 would lead to a TAC, which deviates by more than 15% from the TAC of the preceding year, the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.

3. During 2011, after obtaining advice from ICES, the Parties will refine the management plan, in particular to allow for a reduction in the target fishing mortality when recruitment to the stock has been low for a period of years.

Annex 4: DRAFT Iberian waters advice sheet

7.1.1 5.2.2.1 Mixed fisheries advice for the Bay of Biscay and Atlantic Iberian Waters

Scenarios for 2016

Mixed-fisheries considerations are based on the single-stock assessments combined with knowledge on the species composition in catches in Atlantic Iberian waters fisheries. Mixed fisheries scenarios are based on central assumptions that fleet's fishing patterns and catchability in 2015 and 2016 are the same as those in 2014 (similar to procedures in single-stock forecasts where growth and selectivity are assumed constant). Six example scenarios of fishing opportunities considering mixed fisheries are presented, taking into account the single-stock advice for fisheries catching hake, four-spot megrim, megrim and white anglerfish. Without specific mixed-fisheries management objectives, ICES cannot recommend specific scenario(s).

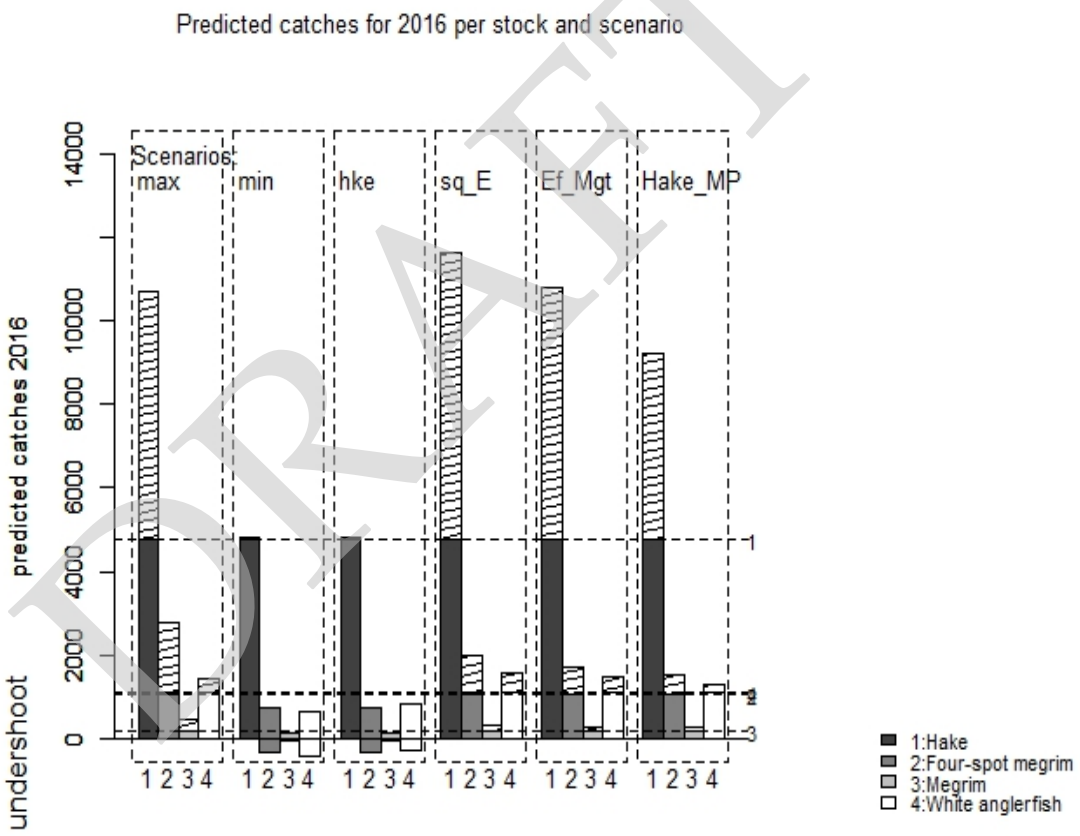


Figure 5.2.2.1.1. Iberian mixed-fisheries projections. Estimates of potential catches (in tonnes) by stock and by scenario. Horizontal lines correspond to the FCube baseline run catches for 2016 – some difference in catch from the single stock advice are found due to different forecasting methods used (see quality considerations). Bars below the value of zero show undershoot (compared to single-stock advice) where catches are predicted to be lower when applying the scenario. Hatched columns represent catches in overshoot of the single-stock advice.

Table 5.2.2.1.1. Mixed-fisheries scenarios for the Iberian stocks.

Scenarios	
max	**"Maximum":** For each fleet, fishing stops when all stocks have been caught up to the fleet's stock shares*. This option causes overfishing of the single-stock advice possibilities of most stocks.
min	**"Minimum":** For each fleet, fishing stops when the catch for any one of the stocks meets the fleet's stock share. This option is the most precautionary option, causing underutilization of the single-stock advice possibilities of other stocks.
hke	**"Hake":** All fleets set their effort corresponding to their hake quota share, regardless of other catches.
sq_E	**'*Status quo* effort':** The effort is set equal to the effort in the most recently recorded year for which landings and discard data are available (2014).
Ef_Mgt	**"Effort management":** The effort in métiers using gear controlled by the EU effort management regime (Council Regulation (EC) 2015/104; Annex IIB) have their effort adjusted assuming a 10% reduction for vessels with more than 5 tons of catches in 2012 and 2013. In the absence of detailed official data, in an exploratory way, this reduction has been applied to those metiers targeting hake.
Hake_MP	**"Hake Managemet Plan":** The hake TAC is calculated applying the constraint on inter-annual variation in TAC (15%) established by the current hake management plan (Council Regulation (EC) No 2166/2005; Article 7), while the fleet dynamics is set as in the "hke" scenario.

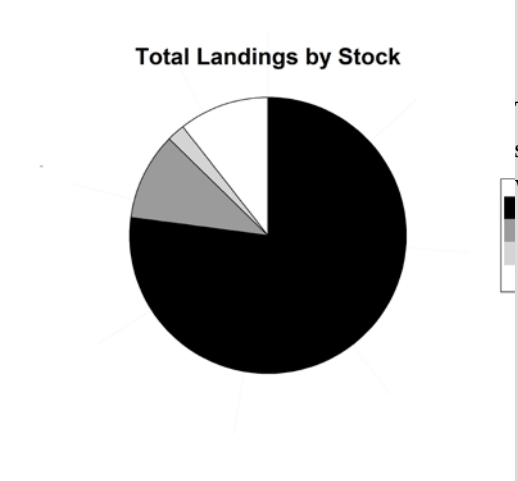
* Throughout this document, the term 'fleet's stock share' or 'stock share' is used to describe the share of the fishing opportunities for each particular fleet, which has been calculated based on the single-stock advice for 2016 and the historical proportion of the stock landings taken by the fleet.

The fisheries

Fleet and métier categories used in the mixed-fisheries analysis are based on the EU data collection framework (DCF) level 5 (Portuguesse fleets) and 6 (Spanish fleets) categories. Fleet categories are based on the DCF fleet segments, but only trawl vessels were provided by size range. Both fleet segments and metiers provided a more detailed segmentation that those specified in the hake long-term management plan.

Catch distribution

Table 5.2.2.1.2. Mixed-fisheries advice for Iberian stocks. Catch distribution.



Total landings (2014) of all species considered in the mixed-fisheries advice were 18 956 t with:

- ~ 37% landed by otter trawls;
- ~ 21% by gill- and trammelnets;
- ~ 18% by bottom pair trawls;
- ~ 8% by set longlines; and
- ~ 15% by a miscellaneous group of gears dominated by small scale vessels.

Total discards were 3 411 t (18% by weight of total catch).

Quality considerations

All scenarios were run assuming that fishing opportunities are calculated for total catches and all catches count against the TAC.

Mixed-fisheries projections build on single-stock assessments, most of which are of high quality and precision. Single-stock forecasts are also reproduced independently as part of the mixed-fisheries analyses, allowing additional quality control of both processes. For those stocks assessed by using length-based models such as hake (GADGET: Frøysa et al., 2002; Begley and Howell, 2004) and white anglerfish (SS3: Methot, 2000; Methot, 2011) the FCube baseline runs provide results around 20% lower than the single stock forecasts at the same fishing mortality rate. Extensive investigation into the causes of this concluded it was a model-based difference rather than an FCube implementation issue. The working group concluded that this did not affect the main conclusions of the mixed fisheries analyses (most and least limiting stocks), but results are presented relative to the FCube baseline runs rather than the single stock advice.

The quality of métier-based catch data has improved this year because of the joined ICES data call combining data needs and ensuring common data storage in Intercatch for single-stock assessment and mixed-fisheries forecasts. Therefore, in 2015, the coverage, timing and quality of data submission were as requested.

Reference points

The reference points for the various stocks can be found in the single-stock advice sheets (ICES, 2015a).

Basis of the assessment

Table 5.2.2.1.3 Mixed-fisheries advice for Iberian stocks. The basis of the assessment.

ICES STOCK DATA CATEGORY	**1 (ICES 2015B)**
Assessment type	F-Cube (FLR).
Input data	Assessments on the relevant stocks in the Bay of Biscay and Iberain waters Ecoregion working group (WGBIE; ICES, 2015c), catch and effort by fleet and metiers.
Discards and bycatch	Included as in the single-stock assessments.
Indicators	None.
Other information	A preliminary version of this assessment was presented at WGMIXFISH in 2013 with the southern stock of horse mackerel (Division IXa) also cosidered. However, this stock was not included in the mixed-fisheries analysis this year because of the assessment of this stock has not yet been updated by WGHANSA.
Working group	Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE). Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE).

Catch options

The single-stock advice of the Iberian stocks considered is based on the MSY approach. The mixed fisheries advice follows the single-stock advice, while taking account of mixed fisheries interactions.

ICES provides six example mixed fishery scenarios. Alternative scenarios taking account of other specific management objectives can be considered. Scenarios are based on central assumptions that fishing patterns and catchability in 2015 and 2016 are the same as those in 2014 (similar to procedures in single-stock forecasts where growth and selectivity are assumed constant). Options that result in under- or overutilization are useful in identifying the main points of friction between the fishing opportunities of the various stocks. They indicate in which direction fleets may have to adapt to fully utilize these catch opportunities.

The "max" scenario demonstrates the upper bound of potential fleet effort and stock catches. However, through assuming that all fleets continue fishing until all their stock shares are exhausted irrespective of the economic viability of such actions, this scenario is generally considered with low plausibility. However, in this case the results were very similar to those provided by the "sq_E" scenario (effort equal to 2014 effort), probably indicating that the fishery is close to the maximum of its activity.

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 by 67% of its 2014 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.

Beside the "max" and "min" scenarios, which are shown to bound the results rather than provide realistic levels of catches in 2016, four intermediate, more likely, scenarios were also considered taking into the current management measures in place. The "hake" scenario gives a result very similar to 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 lost of fishing opportunities for other stocks in a mixed-fisheries context. In this scenario it is assumed that effort reductions in fleets (to achieve new partial Fs) apply equally to all fleets with hake catch. With the exception of the gillnet métier called "rasco" which is directed exclusively to white anglerfish, hake is a species caught by all metiers and so all fleets are limited by this stock. As a result, effort reductions resulting from management of hake also affect the ability to exploit the other stocks.

The "sq_E" scenario provides even higher catch possibilities for hake than the "max" scenario. This potentially indicates that the fishery is close to the maximum of its activity, particularly in terms of exploitation of hake.

The "Ef_Mgt" scenario gives the expected outcome if the nominal effort reductions stipulated in the southern hake effort management plan was translated in full into actual effort cuts and if there existed a 1:1 relationship between fleet effort and mean F. A 10% effort reduction is set in 2015 (Council Regulation (EU) 2015/104; Annex IIB) compared to the 2014 effort (Council Regulation (EU) No 43/2014; Annex IIB) for determined category of vessels. In the absence of official data detailing the number of vessels affected or excluded from the effort reduction, a general assumption was made by applying the established 10% effort reduction to all those metiers targeting hake. The results of this scenario provides similar hake catches than the "max" scenario, but smaller catches for the remaining stocks.

The "Hake_MP" scenario gives the expected outcome if the constraint on inter-annual variation in TAC (15%) established by the current hake management plan was applied, while the fleet dynamics is set as in the "hke" scenario. The results of the "Hake_MP" scenario provides lower catches than the "max" and "sq_E" scenarios for all stocks.

Table 5.2.2.1.4 Mixed-fisheries advice for Iberian stocks. Catch options for 2016 for single-stock advice (in thousand tonnes) and mixed-fisheries scenarios (mixed fisheries catches are expressed relative to Fcube single-stock baselines).

Basis: Single-stock spawning-stock biomass (SSB) at the end of 2014 and assumptions on F in 2015 and SSB at the start of 2016. Fishing patterns and catchability in 2015 and 2016 were assumed to remain as in 2014. The Status quo effort scenario (Sq_E) is assumed to take place in 2015.								
Stock	Single-stock catches advice 2016 (WGBIE 2015)	Single-stock catches advice 2016 (WGMIXFISH 2015)	Catches per mixed-fisheries scenario 2016 relative to the single-stock catch advice					
			"Max"	"Min"	"Hke"	"Sq_E"	"Ef_Mgt"	"Hake_MP"
Hake VIIIc-IXa	6078	4758	2.25	1.01	1.01	2.44	2.27	1.94
Four-spot megrim VIIIc-IXa	1072	1072	2.57	0.70	0.71	1.85	1.59	1.42
Megrim VIIIc-IXa	186	186	2.45	0.71	0.72	1.81	1.58	1.41
White anglerfish VIIIc-IXa	1343	1108	1.32	0.61	0.74	1.42	1.35	1.15

Issues relevant for the advice

Management considerations

ICES provides six example scenarios. Alternative scenarios taking account of other specific management objectives could be considered. In particular, the EU is currently working on regional mixed-fisheries management plans. These plans would not include prescriptive single-stock harvest control rules as known from current plans, but would be rather based on F_{MSY} values with ranges and include biomass safeguards (STECF, 2015).

Mixed-fisheries scenarios are based on central assumptions that fishing patterns and catchability in 2015 and 2016 are the same as those in 2014 (similar to procedures in single-stock forecasts where growth and selectivity are assumed constant). Options that result in under- or overutilization are useful in identifying the main points of friction between the fishing opportunities of the various stocks. They indicate in which direction fleets may have to adapt to fully utilize these catch opportunities.

Mixed-fisheries advice considers the implications of mixed fisheries under current TAC and effort regimes, taking into account the fishing pattern and catchability of the various fleets. The projections are presented in terms of catches, where all catches are assumed to count against a fleets' stock shares. Catches under the mixed fisheries scenarios were consistent with the catch proportion by country in 2014, except for hake under "max" scenario, whose distribution in 2016 leads to an increase in the Portuguese hake catch share.

The "hake" scenario reflects the fishing mortality corresponding to the single-stock advice for hake (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 67% in hake F is required (from 0.73 in 2015 to 0.24 in 2016). In this scenario it is assumed that effort reductions in fleets (to achieve new partial Fs) apply equally to all fleets with any hake catch, including those where it represents a

small bycatch component. Only this stock was considered rather than others because hake resulted the limiting species in previous analyses (ICES, 2013).

Catch and landing advice

The mixed fisheries projections are presented in terms of catch, reflecting the move towards a landings obligation in EU fisheries from 2016. Discards are included in the assessment of hake and both megrim stocks, so these are present as total catches, while the white anglerfish assessment only includes landings, so landing are presented here also.

Species involved

The species considered here as part of the Atlantic Iberian demersal mixed fisheries are hake, four-spot megrim, megrim, and white anglerfish. Other stocks were not included due to the lack of analytical assessment, with the exception of black anglerfish whose analytical assessment is developed by ASPIC model and do not provide absolute population parameters (Prager, 1994; Prager, 2004). Pelagic stocks are not included despite some of them having strong technical interaction with demersal fisheries in Iberian waters. Mackerel and blue whiting stocks cover wider geographical areas than Iberian waters with the majority of catch outside the area considered. The southern stock of horse mackerel (ICES Division IXa), included in the 2013 mixed-fisheries analysis, could not be included because WGHANSA had not undertaken an updated assessment for the stock before the WGMIXFISH-ADVICE meeting.

Table 5.2.2.1.5 Mixed-fisheries advice for Iberian stocks. Advice, management areas and management plans for the stocks considered.

Species	ICES single-stock advice area	Management area	Management plan ref(s)
Hake	Divisions VIIIc and IXa	Divisions VIIIc and IXa	Regulation CE Nº 2166/2005
Four-spot megrim	Divisions VIIIc and IXa	Divisions VIIIc and IXa	n/a
Megrim	Divisions VIIIc and IXa	Divisions VIIIc and IXa	n/a
White anglerfish	Divisions VIIIc and IXa	Divisions VIIIc and IXa	n/a

Data and methods

The projections made use of data requested by the 2015 joined ICES data call. The general use of EU Data Collection Framework (DCF) métiers and also the uniformity of formats required by the ICES database InterCatch has greatly facilitated the compilation of mixed-fisheries data, allowing the required consistency between catch totals supplied to ICES. To allow consideration of fleets defined by length categories, separate data files containing total weight of landings and discards and effort in kW-days by fleet and métier were specifically requested by WGMIXFISH.

All analyses were conducted using the Fcube method (Ulrich et al., 2011).

Uncertainties in the assessment

The quality of the individual forecasts of the single stocks may affect the results of the mixed fisheries scenarios. An error or bias the forecast of one stock could lead to an inappropriately low or high TAC for this stock. This in turn would affect the estimated effort required for each metier to land this TAC. If the effort required to land the TAC for this stock is pivotal in any of the scenarios examined, this would affect the exploitation prognoses of the other stocks in this scenario. In other words, the quality of the

mixed fisheries model is limited by the stock which has the most biased assessment, if that stock is the limiting factor in a mixed fisheries scenario.

Also, an assumption in the forecast is that catchability for fleets remains constant, but this is heavily dependent on fishing patterns, which may change over time.

Another assumption is that the selectivity is the same for all the fleets (based on the F at age as coming from the assessment). Therefore changes in the relative contribution of each fleet to the total effort cannot be translated in specific changes in the relative F at age. This prevents from taking advantage of better selection patterns of some fleets (such as gill netters) in achieving the MSY approach. With the use of Intercatch, the possibility of using catch at age by fleet is being investigated.

The effort management scenario assumes a reducing effort will reduce fishing mortality proportionally. Studies have indicated that the strength of linkages between effort and F differ depending on fleet and species (STECF, 2013).

The quality of data had improved since last mixed-fisheries analysis in 2013 because of the ICES data calls, merging data needs and ensuring common data storage for single-stock assessment and mixed-fisheries forecasts.

Comparison of the basis of previous assessment and advice

This is the first year the Atlantic Iberian waters mixed-fisheries assessment and advice has been produced. The basis for the advice is presented through a series of mixed-fisheries scenarios which illustrate the consequences of single-species advice when catches are taken as part of a mixed fishery.

Summary of the assessment

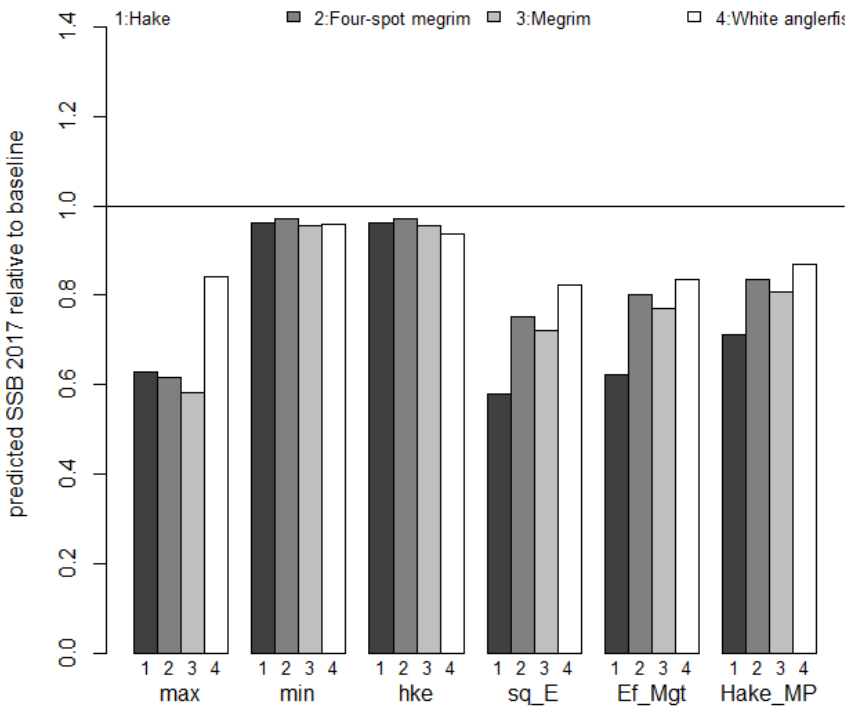


Figure 5.2.2.1.2. Mixed-fisheries advice in Atlantic Iberian waters. Estimates of potential SSB at the start of 2017 by stock after applying the mixed-fisheries scenarios, expressed as a ratio to the single-stock advice forecast. Horizontal line corresponds to the SSB resulting from the single-stock advice (at the start of 2017).

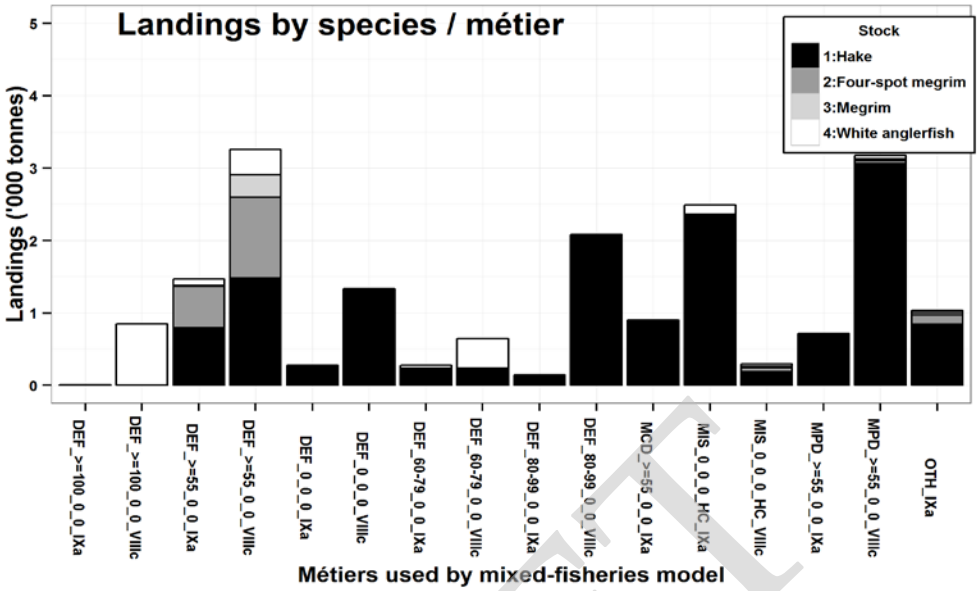


Figure 5.2.2.1.3. Mixed-fisheries advice in Atlantic Iberian waters. Landings distribution of species by métier. Note: The "other" (OTH) displayed here is a landings without corresponding effort.

Table 5.2.2.1.6. 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 ("*rasco*") targeting white anglerfish in ICES Division VIIIc with mesh size of 280 mm
GNS_DEF_60-79_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 60-79 mm	Spanish small set gillnet ("*beta*") targeting a variety of demersal fish in Northern Spanish waters with nets of 60 mm mesh size
GNS_DEF_80-99_0_0	Set gillnet targeting demersal fish with mesh sizes within the range 80-99 mm	Spanish set gillnet ("*volanta*") targeting hake in Northern Spanish waters with nets of 90 mm mesh size
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 Northern 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	-----	Portuguese and Spanish polyvalent artisanal fleet
OTB	----	Portuguese bottom otter trawl
OTB_DEF_>=55_0_0	Bottom otter trawl targeting demersal fish using mesh sizes larger than 55 mm	Spanish bottom otter trawl targeting demersal fish using "*baca*" nets of 70 mm mesh size in Northern Spanish waters

Acronym	DCF definition	Description
OTB_ MCD_>=55_0_0	Bottom otter trawl targeting mixed crustaceans and demersal fish using mesh sizes larger than 55 mm	Spansih bottom otter trawl targeting demersal fish and crustaceans in Southern Iberian waters (Gulf of Cadiz) using nets of 55 mm mesh size
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 and demersal fish in Northern Spanish waters by using "*jurelera*" nets of 55 mm mesh size
PTB_ MPD _>=55_0_0	Bottom pair trawl targeting mixed pelagic and demersal fish using mesh sizes larger than 55 mm	Spanish bottom pair trawl targeting pelagic and demersal fish in Northern Spanish waters by using nets of 55-70 mm mesh size

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Annex 5: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
Youen Vermard, France to be proposed new Chair of WGMIXFISH-ADVICE and WGMIXFISH-METH	ICES secretariat and ACOM
ICES and STECF liase to where possible align data needs for WGMIXFISH and the STECF Annual Economic Report (AER) and Fisheries Dependent Information (FDI) meeting to facilitate development of bioeconomic mixed fisheries models.	ICES secretariat and RCMs
ICES Secretariat to consider the best timing of the working group to ensure that advice can be developed as provided to customers needs given the timing of assessment working groups (WGNSSK, WGCSE, WGBIE) feeding into the mixed fisheries advice.	ICES secretariat and WGMIXFISH

Annex 6: Proposed ToR for 2016 WGMIXFISH–ADVICE Meeting

WGMIXFISH-NS – Working Group on Mixed Fisheries Advice

2015/2/ACOM22 The **Working Group on Mixed Fisheries Advice** (WGMIXFISH-ADVICE), chaired by Youen Vermard, France, will meet at ICES Headquarters, 23–27 May

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 VIId and plaice VIId that is produced by WGNSSK in May 2016, 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, whiting and *Nephrops norvegicus* that is produced by WGCSE in 2016, 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 2016, and the management measures in place for 2017 and further develop advice for the region;

Produce a draft mixed-fisheries section for the ICES advisory report 2015 that includes a dissemination of the fleet and fisheries data and forecasts for the North Sea, [and where possible the Celtic Sea and Iberian waters];

WGMIXFISH will report by 3 June 2016 for the attention of ACOM.

Supporting Information

Priority:	The work is essential to ICES to progress in the development of its capacity to provide advice on multispecies fisheries. Such advice is necessary to fulfil the requirements stipulated in the MoUs between ICES and its client commissions.
Scientific justification and relation to action plan:	The issue of providing advice for mixed fisheries remains an important one for ICES. The Aframe project, which started on 1 April 2007 and finished on 31 March 2009 developed further methodologies for mixed fisheries forecasts. The work under this project included the development and testing of the Fcube approach to modelling and forecasts. In 2008, SGMIXMAN produced an outline of a possible advisory format that included mixed fisheries forecasts. Subsequently, WKMIXFISH was tasked with investigating the application of this to North Sea advice for 2010. AGMIXNS further developed the approach when it met in November 2009 and produced a draft template for mixed fisheries advice. WGMIXFISH has continued this work since 2010.
Resource requirements:	No specific resource requirements, beyond the need for members to prepare for and participate in the meeting.
Participants:	Experts with qualifications regarding mixed fisheries aspects, fisheries management and modelling based on limited and uncertain data.
Secretariat facilities:	Meeting facilities, production of report.
Financial:	None

Linkages to advisory committee:	ACOM
Linkages to other committees or groups:	SCICOM through the WGMG. Strong link to STECF.
Linkages to other organizations:	This work serves as a mechanism in fulfilment of the MoU with EC and fisheries commissions. It is also linked with STECF work on mixed fisheries.

Annex 7: Mixed Fisheries Stock Annexes – Updated

North Sea Mixed Fisheries Annex

Mixed Fisheries Annex

Regional specific documentation of standard assessment procedures used by ICES.

Eco-Region: North Sea

Working Group: Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)

Last updated: May 2015

Last updated by: WGMIXFISH-ADVICE

A. General

A.1. Area definition

This mixed fisheries advice will consider finfish species in the ICES area IV, IIa, IIIa, VI and VIId and for *Nephrops norvegicus* in functional units FU5, FU6, FU7, FU8, FU9, FU10, FU32, FU33, FU34 and ICES' rectangles outside of these nine functional units – denoted FUOTH.

The species considered are part of the demersal mixed fisheries of the North Sea and eastern English channel, and are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. There are nine *Nephrops* functional units in the North Sea, which are considered as separated stocks. However, only four of these can be assessed through fishery-independent abundance estimates from underwater video surveys, and these were kept as distinct stocks. These cover the stocks along the English and Scottish coast; i.e. FU 6 (Farn Deep), FU 7 (Fladen Ground), FU 8 (Firth of Forth) and FU 9 (Moray Firth). The five other functional units (FU 5, FU 10, FU 32, FU 33 and FU 34) have no independent abundance estimates.

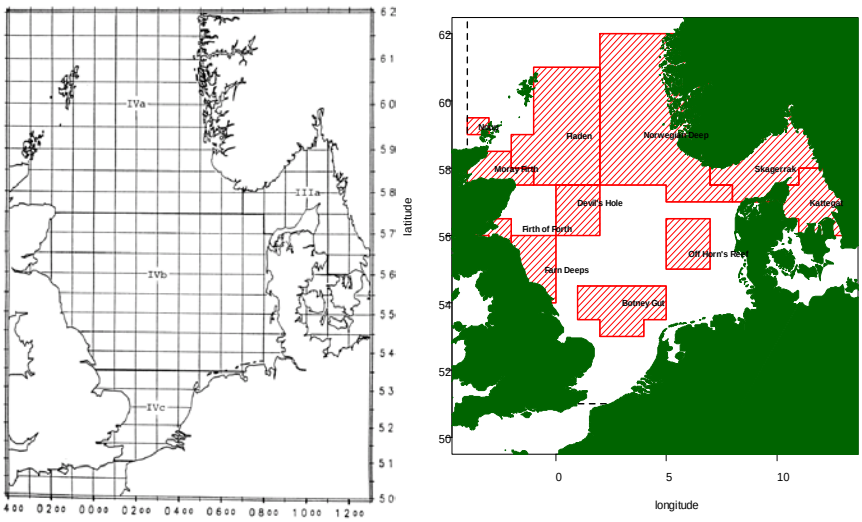

Figure 1 Area description for finfish advice and *Nephrops* Functional Units (FU) in the North Sea and Skagerrak/Kattegat region.

Table 1 *Nephrops* Functional Units (FU) in the North Sea.

FU no.	Name	ICES area	Statistical rectangles
5	Botney Gut - Silver Pit	IVb,c	36-37 F1-F4; 35F2-F3
6	Farn Deeps	IVb	38-40 E8-E9; 37E9
7	Fladen Ground	IVa	44-49 E9-F1; 45-46E8
8	Firth of Forth	IVb	40-41E7; 41E6
9	Moray Firth	IVa	44-45 E6-E7; 44E8
10	Noup	IVa	47E6
32	Norwegian Deep	IVa	44-52 F2-F6; 43F5-F7
33	Off Horn Reef	IVb	39-41E4; 39-41F5
34	Devil's Hole	IVb	41-43 F0-F1

Finfish stocks

Species	**ICES single stock advice area**
Cod	Subarea IV, Divison VIId and IIIa West (Skagerrak)
Haddock	Subarea IV (North Sea) and Division IIIa West (Skagerrak)
Whiting	IV and VIId
Saithe	Subarea IV, Division IIIa West (Skagerrak) and Subarea VI
Plaice	Sub-area IV
Sole	Sub-area IV
Turbot	Sub-area IV
Plaice	Sub-area VIId
Sole	Sub-area VIId

Herring, mackerel and the industrial fisheries (sandeel, Norway pout and sprat) are not considered in a mixed fisheries advice context given the targeted nature of their fleets.

A.2. Fishery

Cod in IIIa – IV – VIId

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including otter trawls, beam trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species. In some of them cod the fisheries are directed mainly towards cod (for example, some of the fixed gear fisheries), and in others considered to be a by-catch (for example in beam trawls targeting flatfish). An analysis of landings and estimated discards of cod by gear category (excluding Norwegian data) highlighted the following fleets as the most important in terms of cod for 2003–5 (accounting for close to 88% of the EU landings), listed with the main use of each gear (STECF SGRST-07-01):

- Otter trawl, ≥ 120 mm, a directed roundfish fishery by UK, Danish and German vessels.
- Otter trawl, 70–89mm, comprising a 70–79mm French whiting trawl fishery centered in the Eastern Channel, but extending into the North Sea, and an 80–89mm UK *Nephrops* fishery (with smaller landings of roundfish and angler-fish) occurring entirely in the North Sea.

- Otter trawl, 90–99mm, a Danish and Swedish mixed demersal fishery centered in the Skagerrak, but extending into the Eastern North Sea.
- Beam trawl, 80–89mm, a directed Dutch and Belgian flatfish fishery.
- Gillnets, 110–219mm, a targeted cod and plaice fishery.

For Norway in 2007, trawls (in the saithe fishery) and gillnets account for around 60% (by weight) of cod catches, with the remainder taken by other gears mainly in the fjords and on the coast, whereas in the Skagerrak, trawls and gillnets account for up to 90% of cod catches. The minimum catching size of cod for Norwegian vessels was increased to 40 cm in 2008.

ICES in 2009 (WGFTFB) has noted a change in effort from far sea fishing grounds in mixed fisheries due to increased fuel costs from 2008 to 2009. Probably there is a significant change in fishing pattern from area IV to Porcupine, Rockall and Celtic Sea.

With regard to trends in effort for these major cod fisheries since 2000, the largest changes in North Sea fisheries have involved an overall reduction in trawl effort and changes in the mesh sizes in use, due to a combination of decommissioning and days-at-sea regulations. For otter trawls, vessels are using either 120 mm+ (in the directed whitefish fishery), 100–119 mm in the Southern North Sea Plaice fishery, or 80–99 mm (primarily in the *Nephrops* fisheries and in a variety of mixed fisheries). The use of other mesh sizes largely occurs in the adjacent areas, with the 70–79 mm gear being used in the Eastern Channel/Southern North Sea Whiting fishery, and the majority of the landings by 90–99 mm trawlers coming from the Skagerrak. Higher discards are associated with these smaller mesh trawl fisheries, but even when these are taken into account, the directed roundfish fishery (trawls with ≥ 120 mm mesh) still has the largest impact of any single fleet on the cod stock, followed by the mixed demersal fishery (90–99 mm trawls) in the Skagerrak.

Apart from the technical measures set by the Commission, additional unilateral measures are in force in the UK, Denmark and Belgium. The EU minimum landing size (mls) is 35 cm, but Belgium operates a 40 cm mls, while Denmark operate a 35 cm mls in the North Sea and 30 cm in the Skagerrak. Additional measures in the UK re-late to the use of square mesh panels and multiple rigs, restrictions on twine size in both whitefish and *Nephrops* gears, limits on extension length for whitefish gear, and a ban on lifting bags. The use of technical meaures in the UK *Nephrops* fishery has particularly increased in 2012 following an agreement at the 2011 December Council fisheries Council on a requirement for UK vessels to use highly selective gear for part of the year. In 2001, vessels fishing in the Norwegian sector of the North Sea had to comply with Norwegian regulations setting the minimum mesh size at 120 mm. Since 2003, the basic minimum mesh size for towed gears targeting cod is 120 mm.

Haddock in IIIa – IV

The largest proportion of the haddock stock is taken by the Scottish demersal whitefish fleet. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland) and VIb (Rockall): it is also a multi-species fishery that lands a number of species other than haddock.

Plaice in IV

Plaice is predominantly caught by beam trawlers in the central part of the North Sea and in a mixed fishery with sole in the southern North Sea, though significant quanities are also taken by a directed otter trawl fishery using 100–119 mm in the Southern North Sea. Technical measures applicable to the mixed flatfish beam trawl fishery affect both

sole and plaice. The minimum mesh size of 80 mm selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which has a larger minimum landing size than sole. Recent discard estimates indicate fluctuations around 45% discards in catch by weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. There has been increased use of new gears such as "SumWing" and electric "pulse trawls" which will increasingly affect catchability and selectivity of plaice and sole. ICES considered that pulse trawls experienced lower catch rates (kg hr^{-1}) of undersized sole and higher catch rates of marketable sole, compared to standard beam trawls (ICES, 2006). Plaice catch rates decreased for all size classes. In 2011, approximately 30 derogation licenses for pulse trawls were operational in the Netherlands, increasing to 42 in 2012. Debate is ongoing in the EU about possible amendments to EU regulations that would permanently legalize the use of pulse gears for the whole fleet. The overall capacity and effort of North Sea beam trawl vessels has been substantially reduced since 1995, including the decommissioning of 25 vessels in 2008.

Saithe in IIIa – IV – VI

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water along the Northern Shelf edge and the Norwegian Trench. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3–4) often are targeted during the rest of the year. In recent years the French fishery has deployed less effort along the Norwegian Trench, while the German and Norwegian fisheries have maintained their effort there. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2–4). In the Norwegian coastal purse seine fishery inside the 4 nm limit (south of 62°N), the minimum landing size is 32 cm. For other gears in the Norwegian zone (south of 62°N) the current minimum landing size is 40 cm, while in the EU zone it is 35 cm. In 2009 the landings were estimated to be around 105 000 t in Sub-area IV and Division IIIa, and 7000 t in Sub-Area VI, which both are well below the TACs for these areas (125 934 and 13 066 t respectively). Significant discards are observed only in Scottish trawlers. However, as Scottish discarding rates are not considered representative of the majority of the saithe fisheries, these have not been used in the assessment.

Sole in IV

Sole are mainly caught in a mixed beam trawl fishery with plaice and other flatfish using 80 mm mesh in the southern North Sea. The minimum mesh size in the mixed beam trawl fishery in the southern North Sea means that large numbers of undersized plaice are discarded.

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, which fish mainly along the English coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn. In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localized areas of deeper water.

The minimum landing size for sole is 24 cm. Demersal gears permitted to catch sole are 80 mm for beam trawling and 90 mm for otter trawlers. Fixed nets are required to

use 100 mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

Whiting in IV – VIId

For whiting, there are three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel. In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. Some vessels operating to the east of this area are using 130 mm mesh. These are mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Minimum mesh size in *Nephrops* trawls is 80 mm but a range of larger mesh sizes are also used when targeting *Nephrops*. Whiting is becoming a more important species for the Scottish fleet, with many vessels actively targeting whiting and Scottish single seiners have been working closer to shore to target smaller haddock and whiting. The derogation in the EU effort management scheme allowing for extra days fishing by vessels using 90 mm mesh gears with a 120 mm square mesh panel close to the codend (a configuration which releases cod) has so far, been taken up by few vessels. Recent fuel price increases and a lack of quota for deepwater species has resulted in some vessels formerly fishing in deepwater and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting.

Whiting are an important component in the mixed fishery occurring along the English east coast. Industry reports suggest better catch rates here than are implied by the overall North Sea assessment. There has been a displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

Whiting are a bycatch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through bycatch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small meshed gear is permitted, subject to bycatch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the bycatch limits are likely to be exceeded.

WGFTFB (2008) reported use of bigger meshes in the top panel of beam trawler gear by Belgium vessels with an expected reduction in by-catch of roundfish species, especially haddock and whiting. Fluctuations in fuel costs can cause changes in fishing practices. WGFTFB (2008) reported a shift for Scottish vessels from using 100–110 mm for whitefish on the west coast ground (Area VI) to 80 mm prawn codends in the North Sea (area IV), with increased fuel costs considered the major driver.

Nephrops

Nephrops is caught in a mixed fishery which takes a catch consisting of haddock, whiting, cod, anglerfish and megrim as well as *Nephrops*. Most of the catch (approx 21 of 25 thousand tons) is taken by UK. Days at sea limits apply to *Nephrops* trawlers when using mesh sizes 70–99 mm and in 2009, under the Scottish Conservation Credits

Scheme (CCS), the number of days available to Scottish vessels is the same as 2008 and 2007.

A small but increasing proportion of the landings from Subarea IV are taken from statistical rectangles outside the defined *Nephrops* FUs. An example is the Scottish fishery at the Devil's hole which a few boats normally fishing the Fladen grounds prosecute for a few months at the end of the year.

Turbot in IV

In recent years, most of the landings stem from the Netherlands (~50–60%). In most countries turbot is caught in mixed fisheries trawls, with most of the landings in the Netherlands coming from the 80 mm beam trawl fleet (BT2) fishing for sole and plaice. In Denmark, the second largest contributor to the landings in recent times, there is a directed fishery for turbot using gillnets (~10% of the total landings).

A combined EU TAC for turbot and brill is set for EU waters in areas IIa and IV. This TAC only applies to the EU fisheries. This management area (particularly the inclusion of area IIa) does not correspond to either of the stock areas defined by ICES for turbot and brill.

Plaice in VIId

Plaice is mainly caught in 80 mm beam-trawl (Belgian and English) fisheries for sole or in mixed demersal fisheries using otter trawls (mainly French). There is also a directed fishery during parts of the year by inshore trawlers and netters. Fisheries operating on the spawning aggregation in the beginning of the year catch plaice that originate from the North Sea, Divisions VIId and VIIe components. Since the 80 mm mesh size does not match the minimum landing size for plaice (27 cm), a large number of undersized plaice are discarded.

Sole in VIId

Sole is mainly caught in 80 mm beam-trawl fisheries with plaice or in mixed demersal fisheries using otter trawls and gill/trammel nets. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts.

A.3. Ecosystem aspects

These are described in the North Sea ecosystem overview in the ICES advisory report.

B. Data

The mixed fisheries assessment is based on catch and effort data that were compiled mostly on the basis of the data collected in annual ICES data calls and data collected by STECF for the evaluation of the effort regime. The data structured by fleets and métiers were used as inputs, together with WGNSSK single-stock data and advice, in the integrated Fcube framework.

The assessment data for the different stocks is taken from the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). For whiting, the industrial bycatch component is included in the landings, whereas it is dealt with separately in the single-stock forecast. The same applied for haddock, for which the industrial bycatch is now extremely low. The single species haddock forecast

also includes some non-standard procedures for projecting mean weight and mean selectivity, and this was accounted for as far as possible in the current mixed-fisheries forecast.

The cod assessment is performed with SAM, which assumes a "catch multiplier" between 1993 and 2005. The reported landings from the different fleets were raised to an "overall landings" estimates using the catch multiplier from the assessment. This multiplier was applied to all fleets.

For *Nephrops* the data collected at ICES and at STECF level until 2009 were not compatible due to differences in aggregation levels. In order to be able to collate both assessment and fleet related data a specific ICES data call was issued for this stock in 2010. This information covers catches and effort exerted by *Nephrops* functional unit so that stock assessments (analytical for FU's 6–9 and trends based for others) can be incorporated into Fcube.

C. Assessment methodology

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), 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.

Model used:

Fcube

The Fcube model is presented and described in Ulrich *et al.* (2006; 2008; 2009). The basis of the model is to estimate the potential future levels of effort by 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 is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

Partial fishing mortality F and catchability q by fleet Fl, métier m and stock St from observed landings LND, effort E and fishing mortality $Fbar$ are estimated for year Y:

$$F(Fl,m,St,Y) = Fbar(St,Y) * \frac{LND(Fl,m,St,Y)}{LNDtot(St,Y)} \quad (1)$$

$$q(Fl,m,St,Y) = F(Fl,m,St,Y) / E(Fl,m,Y) \quad (2)$$

To estimate future parameters value $q(Fl,m,St,Y+1)$ at year *Y+1* an average over recent years can be used. Alternatively, the user may choose to vary the value of q, if

evidence exists of e.g. significant technical creep, or of a change in selectivity due to a change in mesh size.

The observed distribution of effort by fleet across métiers is estimated:

$$Effshare(Fl,m,Y) = E(Fl,m,Y)/E(Fl,Y) \quad (3)$$

As with catchability, the simplest approach to the forecast effort distribution $Effshare(Fl,m,Y+1)$ would be to estimate it from an average of past observed effort allocation. Alternatively, a more complex approach such as a behaviour algorithm could be used if available.

These variables are then used for the forecast estimates of catchability by stock for each fleet. This catchability cannot be directly estimated from observed data, as it is linked to the flexibility of the fleet. While catchability by métier is assumed to be measurable as being linked to the type of fishing, the resulting catchability by fleet varies with the time spent in each métier. The catchability of a fleet is thus equal to the average catchability by métier weighted by the proportion of effort spent in each métier for the fleet:

$$q(Fl,St,Y+1) = \sum_m q(Fl,m,St,Y+1) * Effshare(Fl,m,Y+1) \quad (4)$$

A TAC is usually set in order to achieve a specific fishing mortality. This might be a particular short-term target, such as Fpa, or specific reduction in F as part of a longer-term management plan. This intended F is converted into forecast effort by fleet. This step is rather hypothetical, in that it introduces the concept of "Stock dependent fleet effort". The "stock-dependent fleet effort" is the effort corresponding to a certain partial fishing mortality on a given stock, disregarding all other activities of the fleet. The total intended fishing mortality *Ftarget(St)* is first divided across fleet segments (partial fishing mortalities) through coefficients of relative fishing mortality by fleet. These coefficients are fixed quota shares estimated from observed landings. In principle, these reflect the rigid sharing rules resulting from the principle of relative stability, combined with national processes of quota allocation across fleets. The simplest approach is thus to estimate these from observed mean proportions of landings by fleet. The resultant partial fishing mortalities are subsequently used for estimating the stock-dependent fleet effort:

$$F(Fl,St,Y+1) = Ftarget(St,Y+1) * QuotaShare(Fl,St) \quad (5)$$
$$E(Fl,St,Y+1) = F(Fl,St,Y+1)/q(Fl,St,Y+1)$$

The final input required is the effort by each fleet during the forecast year. It is unlikely that the effort corresponding to each single-species TAC will be the same across fleets, and it is equally possible that factors other than catching opportunities could influence the amount of effort exerted by a given fleet. Rather than assume a single set of fleet efforts, the approach used in practice with Fcube has been to investigate a number of different scenarios about fleet effort during the forecast period. The user can thus explore the outcomes of a number of options or rules about fleet behaviour (e.g. continue fishing after some quotas are exhausted) or management scenarios (e.g. all fisheries are stopped when the quota of a particular stock is reached).

$$E_{Fl,Y} = rule(E_{Fl,St1,Y}, E_{Fl,St2,Y}, E_{Fl,St3,Y} \ldots)$$

For example, if one assumes that fishermen continue fishing until the last quota is exhausted, effort by fleet will be set at the maximum across stock-dependent effort by fleet ("max" option). Overquota catches of species which quota were exhausted before this last one, are assumed to be discarded.

$$E(Fl, Y+1) = MAX_{St}[E(Fl, St1, Y+1), E(Fl, St2, Y+1), ...] \quad (6)$$

As a contrast, a more conservative option would be to assume that the fleets would stop fishing when the first quota is exhausted, and thus would set their effort at the minimum across stocks ("min" option). Alternatively, management plans for a particular stock could be explored, with the fleets setting their effort at the level for this stock ("stock_name" option). Different rules could also be applied for the various fleets.

The following options are explored:

11) **min**: The underlying assumption is that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.

12) **max**: The underlying assumption is that fishing stops when the last quota species is fully utilised with respect to the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.

13) **cod**: The underlying assumption is that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.

14) **sq_E**: The effort is set as equal to the effort in the most recently recorded year for which there is landings and discard data.

15) **Ef_Mgt**: The effort in métiers using gear controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulation (EC) No 1342/2008).

All scenarios will be run with two advice approaches, Fmsy transition and management plan. For stocks where a management plan does not exist, the advice according to the latest commission communication on TAC setting is used.

Finally, this resulting effort by fleet is distributed across métiers, and corresponding partial fishing mortality is estimated.

$$E(Fl, m, Y+1) = E(Fl, Y+1) * Effshare(Fl, m, Y+1) \quad (7)$$
$$F(Fl, m, St, Y+1) = q(Fl, m, St, Y+1) * E(Fl, m, Y+1)$$

Partial fishing mortalities are summed by stock, and then used in standard forecast procedures similar to the ones used in the traditional single-species short-term advice. Corresponding landings are estimated and compared with the single-species TAC.

Software used:

The Fcube model has been coded as a method in R (R Development Core Team, 2008), as part of the FLR framework (Kell *et al*., 2007, www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore 2.2 package, and two forecast methods were used, stf() from the FLAssess (version 1.99–102) and fwd() from the Flash (version 2.0.0) packages. As such, the input parameterisation as well as the stock projections are made externally using existing methods and packages, while only steps 4 to 6 are internalised in the method, thus keeping full transparency and flexibility in the use of the model.

D. Short-Term Projection methodology

Model used: Overview of software used by WGNSSK.

SPECIES	ASSESSMENT	FORECAST
HADDOCK IV, IIIa and VIIb	TSA	MFDP
COD IV, IIIa and VIIb	SAM	SAM
PLAICE IV	FLR 3.0, FLXSA	FLR3.0, FLSTF
WHITING IV and VIId	FLR 2.x, FLXSA	MFDP
SAITHE IV, IIIa and VI	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE IV	FLR 2.x, AAP	FLR 2.x, FLSTF
TURBOT	SAM	FLSTF
NEPHROPS UWTV	none	None
PLAICE VIId	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE VIId	FLR 2.x, FLXSA	FLR 2.x, FLSTF

In the mixed-fisheries runs, all forecasts were done with the same FLR forecasts method (see section C).

For every scenario, the following output is generated per stock:

	Description	Landings	F mult	SSB
Baseline forecast for current year	Applying single species forecast assumptions to last year's data (current year – 1)*	Current yr	Current yr	1st Jan TAC yr
Baseline forecast for TAC year	Applying single species HCRs** to current year results*	TAC yr	TAC yr	1st Jan TAC yr + 1
Current year Fcube results	Applying Fcube to last year's data	Current yr	Current yr	1st Jan TAC yr
Fcube estimate of catches in TAC year	Applying Fcube on current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1
TAC advice results (incl mgt plans)	Applying single species HCRs** to current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1

*** For the Baseline runs, a forecast was run for each stock separately following the same settings as in the ICES single species forecast.**

**** Harvest Control Rules – either from single species management plans or with reference to the F_{MSY} transition approach. Where HCRs according to these approaches were not available values according to the precautionary approach were used.**

The following overview table will be produced to be able to judge the relevance of the different scenarios:

		COD	HAD	PLE	POK	SOL	WHG	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33
Current year	Fbar														
	FmultVsF(cur-1)														
	Landings														
	SSB														
Current year+1	Fbar														
	FmultVsF(cur-1)														
	Landings														
	SSB														
Current year+2	SSB														

G. Biological Reference Points

The biological reference points that are used are the same values as referred to in the single stock advisory reports.

H. Other Issues

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I. References

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Iberian waters Mixed Fisheries Annex

Mixed Fisheries Annex

Regional specific documentation of standard assessment procedures used by ICES.

Eco-Region: South European Atlantic Shelf (G)

Working Group: Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)

Last updated: May 2015

Last updated by: WGMIXFISH-ADVICE

A. General

A.1. Area definition

This mixed fisheries advice will consider finfish species in the ICES Divisions VIIIc and IXa.

The species considered are part of the demersal mixed fisheries of the Atlantic Iberian waters, and are hake, four-spot megrim, megrim and white anglerfish. There are seven *Nephrops* functional units in Iberian waters; however, any of them is currently assessed by analyticcal methods.

Figure .1 Area description for finfish advice in Atlantic Iberian waters.

Table .1 Finfish stocks of Iberian waters included in the mixed-fiseries analyses.

ICES stock code	Species	ICES single stock advice area
hke-soth	Hake	Divisions VIIIc and IXa
mgb-8c9a	Four-spot megrim	Divisions VIIIc and IXa
mgw-8c9a	Megrim	Divisions VIIIc and IXa
anp-8c9a	White anglerfish	Divisions VIIIc and IXa

Table .2 *Nephrops* Functional Units (FU) in Iberian waters (not included in the mixed-fiseries analysis).

FU no.	Name	ICES Division	Statistical rectangles
25	North Galicia	VIIIc	15 E0–E1; 16 E1
26	West Galicia	IXa	13–14 E0–E1
27	North Portugal (North of Cape Espichel)	IXa	6–12 E0; 9–12 E1
28	Southwest Portugal (Alentejo)	IXa	3–5 E0–E1
29	South Portugal (Algarve)	IXa	2 E0–E2
30	Gulf of Cadiz	IXa	2–3 E2–E3
31	Cantabrian Sea	VIIIc	16 E4–E7

Nephrops FU were not included in the mixed-fisheries analysis due to the lack of analytical assessment. Moreover, the southern stock of black anglerfish, other relevant demersal stock Iberian waters, is assessed by a non-equilibrium production model (ASPIC; Prager, 1994) which provides relative population parameters. Nevertheless douthern stock of horse mackerel, which was included in previous analyses (ICES, 2013), had to be eliminated this year due to the mismatch of dates between WGMIXFISH and WGHANSA, so the respective assessments were not available in time.

A.2. Fishery

Hake in VIIIc and IXa

Hake is caught by a multigear fleet (otter trawlers, pair trawlers, gillnetters, longliners, and small-scale artisanal vessels). In the trawl fleet, hake is caught together with megrim, anglerfish, blue whiting, horse mackerel, mackerel, and crustaceans. Discards occur mainly in the trawl fisheries that target smaller fish than gillnetters and longliners.

A recovery plan was agreed by the EU in 2005 (EC Reg. No. 2166/2005). The aim of the plan is 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. ICES has not evaluated the plan.

Four–spot megrim in VIIIc and IXa

The southern four-spot megrim stock is almost exclusively caught in mixed bottom otter trawl fisheries. Landings of this fleet was traditionally compounded of demersal species as megrim, hake, anglerfish, and *Nephrops*.

No specific management objectives are known to ICES.

Megrim in VIIIc and IXa

As wells as four-spot megrim, the megrim southern stock is almost exclusively caught in mixed bottom otter trawl fisheries. Landings of this fleet was traditionally compounded of demersal species as four-spot megrim, hake, anglerfish, and *Nephrops*.

No specific management objectives are known to ICES.

White anglerfish in VIIIc and IXa

White anglerfish is caught by a directed gillnet métier (called "rasco" in Spanish), bottom otter trawl and trammel nets. The last fisheries also catch hake, megrims, balck anglerfish and *Nephrops*. There is no minimum landing size for anglerfish, but a minimum selling weight of 500 g was fixed in 1996 to ensure marketing standards.

Black anglerfish in VIIIc and IXa

Black anglerfish is caught by bottom otter trawl and trammel and gillnet fisheries. These fisheries also catch hake, megrims, white anglerfish and *Nephrops*. There is no minimum landing size for anglerfish, but a minimum selling weight of 500 g was fixed in 1996 to ensure marketing standards.

Nephrops in VIIIc

Nephrops has been traditionally caught in a mixed trawl fishery which takes a catch consisting of hake, four-pot megrim, megrim, white anglerfish and black anglerfish. However, catches of *Nephrops* FU25 and FU31 (Division VIIIc) have been practically irrelevant for years.

Nephrops in IXa

In the catches of *Nephrops* in Division IXa, those from FU26–27 (West Galicia- North Portugal) have been reduced substantially in the last decade. Although at lower levels of their time series, the remaining FU in Division IXa (FU28–29 and FU30) are the only still providing *Nephrops* catches to the fleets targeting crustaceans in Iberian waters.

Besides, two management closures were implemented to trawl and traps in relation to the recovery plan for southern hake and Iberian *Nephros* stocks (EC Reg. No. 2166/2005): one in South Galicia (FU25), from June to August, and another in Southwest Portugal, from May to August.

A.3. Ecosystem aspects

These are described in the Bay of Biscay and Atlatic Iberian waters ecosystem overview in the ICES advisory report.

B. Data

The mixed-fisheries assessment is based on catch and effort data provided by the National laboratories to ICES under the joined 2015 data call. These fishery data, structured by DCF fleet segments and métiers, were used as inputs together with ICES single-stock data and advice, in the integrated Fcube framework.

The assessment data for the different stocks is taken from the ICES Working Group for the Bay of Biscay and the Iberian waters Ecoregion (WGBIE). For hake and both megrims, total catches (landings and discards) are included in the single-stok assessment. The assessment of white anglerfish just include landings.

The hake and monkfish assessments are performed by uing length-based stochastic assessment models, GADGET (Begley and Howell, 2004) and SS3 (Methot, 2000), respectively. GADGET is a forward simulation model, and can be structured in both age and length; therefore requiring direct modelling of growth within the model. SS3 is an integrated assessment model which it is capable to use different sources of information, and where all parameters have a set of controls to allow prior constraints, timevarying, flexibility, and linkages to environmental data.

Both southern stock of megrims, four-spot megrim and megrim, are assessed by applying the XSA method (Shepherd, 1999).

From the demersal stocks not included in the Iberian mixed-fisheries analysis, any *Nephrops* FU is currently assessed by applying analytical methods, so no biological parameters can be provided. As said above, the assessment of the southern stock of black anglerfish do not provide absolute parameters capable of being used in an Fcube mixed-fisheries analysis.

C. Assessment methodology

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) stablished by the Commission Decision of 18 December 2009, (C(2009) 10121), 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.

Model used:

Fcube

The Fcube model is presented and described in Ulrich *et al.* (2011). The basis of the model is to estimate the potential future levels of effort by 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 is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

Partial fishing mortality F and catchability q by fleet Fl, métier m and stock St from observed landings LND, effort E and fishing mortality $Fbar$ are estimated for year Y:

$$F(Fl,m,St,Y) = Fbar(St,Y) * \frac{LND(Fl,m,St,Y)}{LNDtot(St,Y)} \quad (1)$$

$$q(Fl,m,St,Y) = F(Fl,m,St,Y) / E(Fl,m,Y) \quad (2)$$

To estimate future parameters value $q(Fl, m, St, Y+1)$ at year *Y+1* an average over recent years can be used. Alternatively, the user may choose to vary the value of q, if evidence exists of e.g. significant technical creep, or of a change in selectivity due to a change in mesh size.

The observed distribution of effort by fleet across métiers is estimated:

$$Effshare(Fl, m, Y) = E(Fl, m, Y) / E(Fl, Y) \quad (3)$$

As with catchability, the simplest approach to the forecast effort distribution $Effshare(Fl, m, Y+1)$ would be to estimate it from an average of past observed effort allocation. Alternatively, a more complex approach such as a behaviour algorithm could be used if available.

These variables are then used for the forecast estimates of catchability by stock for each fleet. This catchability cannot be directly estimated from observed data, as it is linked to the flexibility of the fleet. While catchability by métier is assumed to be measurable as being linked to the type of fishing, the resulting catchability by fleet varies with the time spent in each métier. The catchability of a fleet is thus equal to the average catchability by métier weighted by the proportion of effort spent in each métier for the fleet:

$$q(Fl, St, Y+1) = \sum_m q(Fl, m, St, Y+1) * Effshare(Fl, m, Y+1) \quad (4)$$

A TAC is usually set in order to achieve a specific fishing mortality. This might be a particular short-term target, such as Fpa, or specific reduction in F as part of a longer-term management plan. This intended F is converted into forecast effort by fleet. This step is rather hypothetical, in that it introduces the concept of "Stock dependent fleet effort". The "stock-dependent fleet effort" is the effort corresponding to a certain partial fishing mortality on a given stock, disregarding all other activities of the fleet. The total intended fishing mortality *Ftarget(St)* is first divided across fleet segments (partial fishing mortalities) through coefficients of relative fishing mortality by fleet. These coefficients are fixed quota shares estimated from observed landings. In principle, these reflect the rigid sharing rules resulting from the principle of relative stability, combined with national processes of quota allocation across fleets. The simplest approach is thus to estimate these from observed mean proportions of landings by fleet. The resultant partial fishing mortalities are subsequently used for estimating the stock-dependent fleet effort:

$$F(Fl, St, Y+1) = Ftarget(St, Y+1) * QuotaShare(Fl, St) \quad (5)$$
$$E(Fl, St, Y+1) = F(Fl, St, Y+1) / q(Fl, St, Y+1)$$

The final input required is the effort by each fleet during the forecast year. It is unlikely that the effort corresponding to each single-species TAC will be the same across fleets, and it is equally possible that factors other than catching opportunities could influence the amount of effort exerted by a given fleet. Rather than assume a single set of fleet efforts, the approach used in practice with Fcube has been to investigate a number of different scenarios about fleet effort during the forecast period. The user can thus explore the outcomes of a number of options or rules about fleet behaviour (e.g. continue fishing after some quotas are exhausted) or management scenarios (e.g. all fisheries are stopped when the quota of a particular stock is reached).

$$E_{Fl,Y} = rule(E_{Fl,St1,Y}, E_{Fl,St2,Y}, E_{Fl,St3,Y} \ldots)$$

For example, if one assumes that fishermen continue fishing until the last quota is exhausted, effort by fleet will be set at the maximum across stock-dependent effort by

fleet ("max" option). Overquota catches of species which quota were exhausted before this last one, are assumed to be discarded.

$$E(Fl, Y+1) = MAX_{St}[E(Fl, St1, Y+1), E(Fl, St2, Y+1), ...] \quad (6)$$

As a contrast, a more conservative option would be to assume that the fleets would stop fishing when the first quota is exhausted, and thus would set their effort at the minimum across stocks ("min" option). Alternatively, management plans for a particular stock could be explored, with the fleets setting their effort at the level for this stock ("stock_name" option). Different rules could also be applied for the various fleets.

The following options are explored:

16) **max**: The underlying assumption is that fishing stops when the last quota species is fully utilised with respect to the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.

17) **min**: The underlying assumption is that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.

18) **hke**: The underlying assumption is that all fleets set their effort at the level corresponding to their hake quota share, regardless of other stocks.

19) **sq_E**: The effort is set as equal to the effort in the most recently recorded year for which there is landings and discard data.

20) **Ef_Mgt**: The effort in métiers using gear controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulation (EC) Nº 2166/2005).

All scenarios are run with the advice approach used in their respective single-tock forecast, i.e. Fmsy approach for all the stocks except for megrim, which is managed applying the four-spot megrim conditions.

Finally, this resulting effort by fleet is distributed across métiers, and corresponding partial fishing mortality is estimated.

$$E(Fl, m, Y+1) = E(Fl, Y+1) * Effshare(Fl, m, Y+1) \quad (7)$$
$$F(Fl, m, St, Y+1) = q(Fl, m, St, Y+1) * E(Fl, m, Y+1)$$

Partial fishing mortalities are summed by stock, and then used in standard forecast procedures similar to the ones used in the traditional single-species short-term advice. Corresponding landings are estimated and compared with the single-species TAC.

Software used:

All analyses were conducted using the FLR framework (Kell *et al.* (2007); 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 ob-jects as inputs and outputs.

D. Short–Term Projection methodology

Model used: Overview of software used by WGBIE.

SPECIES	ASSESSMENT	FORECAST
HAKE VIIIc-IXa	GADGET	GADGET (script: predict.st.sh)
FOUR-SPOT MEGRIM VIIIc-IXa	XSA	MFDP
MEGRIM VIIIc-IXa	XSA	MFDP
WHITE ANGLERFISH VIIIc-IXa	SS3	SS3 (ad hoc R code)

For every scenario, the following output is generated per stock:

Scenario	Description	Landings	F mult	SSB
Baseline forecast for current year	Applying single species forecast assumptions to last year's data (current year – 1)*	Current yr	Current yr	1st Jan TAC yr
Baseline forecast for TAC year	Applying single species HCRs** to current year results*	TAC yr	TAC yr	1st Jan TAC yr + 1
Fcube estimate of catches in TAC year	Applying Fcube on current year results	TAC yr	TAC yr	1st Jan TAC yr + 1

*** For the Baseline runs, a forecast was run for each stock separately following the same settings as in the ICES single species forecast.**
**** Harvest Control Rules.**

The following overview table will be produced to be able to judge the relevance of the different scenarios:

		hke-soth	mgb-8c9a	mgw-8c9a	anp-8c9a
Current year	Fbar				
	FmultVsF(cur-1)				
	Landings				
	SSB				
Current year+1	Fbar				
	FmultVsF(cur-1)				
	Landings				
	SSB				
Current year+2	SSB				

G. Biological Reference Points

The biological reference points that are used are the same values as referred to in the single stock advisory reports.

H. Other Issues

I. References

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Celtic Sea Mixed Fisheries Annex

Mixed Fisheries Annex

Regional specific documentation of standard assessment procedures used by ICES.

Eco-Region:	Celtic Sea
Working Group:	Working Group on Mixed Fisheries Advice (WGMIXFISH-ADVICE)
Last updated:	May 2015
Last updated by:	WGMIXFISH-ADVICE

A. General

A.1. Area definition

This mixed fisheries advice considers finfish species ICES area VII.

The species considered are part of the demersal mixed fisheries of the Celtic Sea, and at present are cod, haddock, whiting.

It is anticipated that *Nephrops norvegicus* will be incorporated in the advice at some point in future. There are seven *Nephrops* functional units within the Celtic Sea, of these all bar FU18 can be assessed through fishery-independent abundance estimates from underwater video surveys. There is evidence that at least some of these *Nephrops* patches are linked in meta-population sense (O'Sullivan *et al*., 2013).

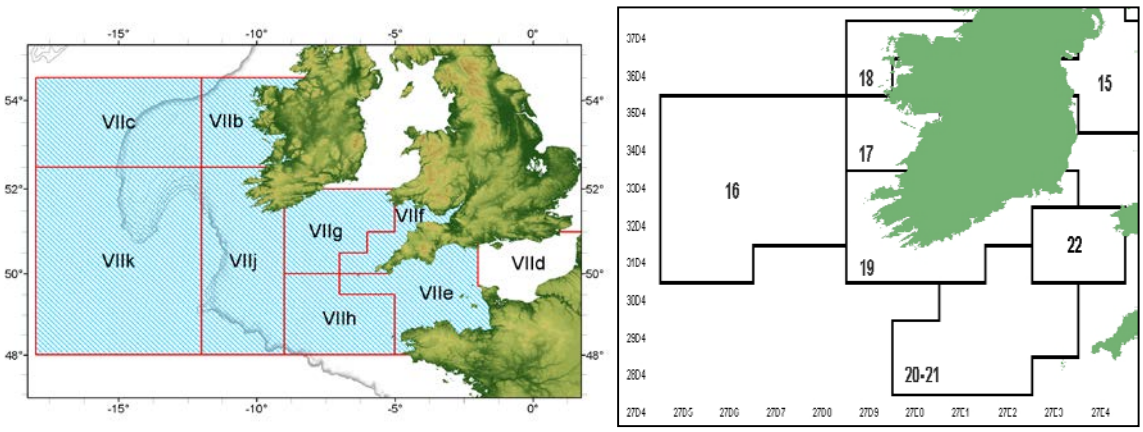

Figure 1 Area description for finfish advice and *Nephrops* Functional Units (FU) in the Celtic Sea region.

Table 1 *Nephrops* Functional Units (FU) in the Celtic Sea.

FU no.	Name	ICES Area	Statistical rectangles
16	Porcupine Bank	VIIb,c,j,k	31–35 D5–D6; 32–35 D7–D8
17	Aran Grounds	VIIb	34–35 D9–E0
19	Ireland SW and SE coasts	VIIa,g,j	31–33 D9–E0; 31 E1; 32 E1–E2; 33 E2–E3
20–21	Celtic Sea – Labadie	VIIg,h	28–29 E0, 28–30 E1; 28–31 E2; 29–30 E3
22	Celtic Sea – the Smalls	VIIg,f	31–32 E3; 31–32 E4

Table 2 Finfish stocks

Species	ICES single stock advice area
Cod	Divison VIIe-VIIk (Celtic Sea)
Haddock	Division VIIbc, VIIe-k (Celtic Sea)
Whiting	Division VIIbc, VIIe-k (Celtic Sea)

Pelagic (herring, mackerel, horse mackerel) and the industrial fisheries (boar fish) are not considered in a mixed fisheries advice context given the targeted nature of the fisheries for these species.

A.2. Fishery

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, whiting), *Nephrops*, hake, anglerfishes, megrims, 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 VIIe and VIIfg) and rays (VIIf). 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 (VIIhjk).

Fishing effort for the main gears (otter trawlers, beam trawlers) has been relatively stable over the past ten years, though there has been an increase in otter trawl effort since 2009 (STECF, 2014), particularly for the large mesh trawlers (> 100 mm). Unlike other parts of the Celtic Seas (VIa, VIIa) and the North Sea and eastern English channel (IV and VIId) the Celtic Sea is not subject to effort control measures under the long-term management plan for cod (excepting beam trawlers and gillnetters in VIIe as part of the western channel sole management plan), and so the increase in effort may be due to limiting effort regulation in other areas.

The mixed gadoid fishery predominately takes place in ICES areas VIIf and VIIg 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.

Recent years have seen large but sporadic recruitment for the gadoid stocks and high levels of exploitation resultng in significant fluctuations in the stocks. Incompatibilities between the quota available has resulted in regulatory discarding as well as high-grading in the mixed fisheries, creating significant challenges in managing the exploitation

of the stocks and leading to the introduction of a number of technical gear measures designed to reduce discarding of under size and over quota fish. Understanding the strength of technical interactions and likely 'choke' stocks will therefore support design of management measures which provide greater consistency between quotas for the different stocks exploited in the mixed fishery. Industry reports of large incoming cod and haddock recruitments, which appear to be supported by observations in scientific surveys, indicate the need for such measures in the immediate future.

Cod in VIIe–k

The majority of the landings are made by demersal trawls targeting gadoids (i.e. cod, haddock and whiting). In recent years an increasing component has come from gillnets and otter trawls targeting *Nephrops* or benthic species and even a small component from beam trawls. Other commercial species that are caught by these fisheries include haddock, whiting, *Nephrops*, plaice, sole, anglerfish, hake, megrim, and elasmobranchs. Landings are made throughout the year but are generally more abundant during the first quarer. Constraining TAC's set since 2003 and the impact of the Trevose Head Closure since 2005 have reduced landings in Q1 and spread landings throughout the year.

Spatially, the majoriy of cod VIIe-k landings originate from area VIIg (~50%) followed by VIIe and VIIh (~20%). Comparitivly low landings come from VIIf (~10%). The contribution of landings by country had been stable for a number of years. Where French landing account for the greatest proportion (~54%), followed by Ireland (~31%), and lower contributions from the United Kingdom (~12%) and Belgium (~4%).

Haddock in VIIbc, VIIe–k

Haddock in Divisions VIIb,c,e–k are taken as a component of catches in mixed trawl fisheries. France takes about 50–80% of the landings, primarily by gadoid trawlers. Trawlers which, prior to 1980 were mainly fishing for hake in the Celtic Sea. Ireland has historically taken the second larges landings, (~25–40%). Fleets from Belgium, Norway, the Netherlands, Spain, and the UK take relatively minor landings.

The vast majority of the landings are taken by otter trawls, most of the remainder of the landings are taken by seines and beam trawls.

Whiting in VIIbc, VIIe–k

Whiting in Divisions VIIbc and e–k are taken as a component of catches in mixed demersal trawl and seine fisheries. The spatial distribution shows several descrite landings concentrations in western waters and the North Sea. Within this stock area there are two regions with a higher volume of landings i) VIIg and the eastern part of VIIj (Celtic Sea Shelf); ii) VIIe (western Channel). The landings by country shows VIIb–k whiting are mostly taken by Ireland and France.

Whiting are caught in directed gadoid trips and as part of mixed fisheries throughout the Celtic Sea, as well as bycatch within *Nephrops* fisheries. Discard rates are high as a consequence of the low market value of the species, particularly at smaller sizes. Highgrading above the MLS to some extent is also prevalent in most fisheries.

[Nephrops – to be included at some point in future

Nephrops is caught in a mixed fishery which takes a catch consisting of haddock, whiting, cod, anglerfish and megrim as well as *Nephrops*. The composition of which can vary with FU. A minor proportion of the landings from Subarea VII are taken from

statistical rectangles outside the defined *Nephrops* FUs. In the Celtic Sea area most are landed from Ireland and France with contributions from the UK and Spain.

Approximatly 60% of the TAC is taken from within the two Irish Sea FUs (FU14 and FU15) not considred within the Celtic Sea mixed fishery.]

A.3. Ecosystem aspects

These are described in the Celtic Seas ecosystem overview in the ICES advisory report.

B. Data

The mixed fisheries assessment is based on catch and effort data that were compiled mostly on the basis of the data collected in annual ICES data calls. The data structured by fleets and métiers were used as inputs, together with single-stock data and advice from the ICES Working Group on the Assessment of Demersal Stocks in the Celtic Seas Ecoregion (WGCES), in the integrated Fcube framework.

The assessment data for the different stocks is taken from the WGCSE, and the forcasting procedures follow those perfomed by this group. The Irish cod, haddock and whiting landings misreporting has been corrected for, consistent with WGCSE. However it was not possible to adjust the associated effort for these corrections.

C. Assessment methodology

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), 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.

Model used:

Fcube

The Fcube model is presented and described in Ulrich *et al.* (2006; 2008; 2009). The basis of the model is to estimate the potential future levels of effort by 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 is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

Partial fishing mortality F and catchability q by fleet Fl, métier m and stock St from observed landings LND, effort E and fishing mortality $Fbar$ are estimated for year Y:

$$F(Fl,m,St,Y) = Fbar(St,Y) * \frac{LND(Fl,m,St,Y)}{LNDtot(St,Y)} \quad (1)$$

$$q(Fl,m,St,Y) = F(Fl,m,St,Y) / E(Fl,m,Y) \quad (2)$$

To estimate future parameters value $q(Fl,m,St,Y+1)$ at year *Y+1* an average over recent years can be used. Alternatively, the user may choose to vary the value of q, if evidence exists of e.g. significant technical creep, or of a change in selectivity due to a change in mesh size.

The observed distribution of effort by fleet across métiers is estimated:

$$Effshare(Fl,m,Y) = E(Fl,m,Y) / E(Fl,Y) \quad (3)$$

As with catchability, the simplest approach to the forecast effort distribution $Effshare(Fl,m,Y+1)$ would be to estimate it from an average of past observed effort allocation. Alternatively, a more complex approach such as a behaviour algorithm could be used if available.

These variables are then used for the forecast estimates of catchability by stock for each fleet. This catchability cannot be directly estimated from observed data, as it is linked to the flexibility of the fleet. While catchability by métier is assumed to be measurable as being linked to the type of fishing, the resulting catchability by fleet varies with the time spent in each métier. The catchability of a fleet is thus equal to the average catchability by métier weighted by the proportion of effort spent in each métier for the fleet:

$$q(Fl,St,Y+1) = \sum_m q(Fl,m,St,Y+1) * Effshare(Fl,m,Y+1) \quad (4)$$

A TAC is usually set in order to achieve a specific fishing mortality. This might be a particular short-term target, such as Fpa, or specific reduction in F as part of a longer-term management plan. This intended F is converted into forecast effort by fleet. This step is rather hypothetical, in that it introduces the concept of "Stock dependent fleet effort". The "stock-dependent fleet effort" is the effort corresponding to a certain partial fishing mortality on a given stock, disregarding all other activities of the fleet. The total intended fishing mortality *Ftarget(St)* is first divided across fleet segments (partial fishing mortalities) through coefficients of relative fishing mortality by fleet. These coefficients are fixed quota shares estimated from observed landings. In principle, these reflect the rigid sharing rules resulting from the principle of relative stability, combined with national processes of quota allocation across fleets. The simplest approach is thus to estimate these from observed mean proportions of landings by fleet. The resultant partial fishing mortalities are subsequently used for estimating the stock-dependent fleet effort:

$$F(Fl,St,Y+1) = Ftarget(St,Y+1) * QuotaShare(Fl,St) \quad (5)$$
$$E(Fl,St,Y+1) = F(Fl,St,Y+1) / q(Fl,St,Y+1)$$

The final input required is the effort by each fleet during the forecast year. It is unlikely that the effort corresponding to each single-species TAC will be the same across fleets, and it is equally possible that factors other than catching opportunities could influence the amount of effort exerted by a given fleet. Rather than assume a single set of fleet efforts, the approach used in practice with Fcube has been to investigate a number of different scenarios about fleet effort during the forecast period. The user can thus explore the outcomes of a number of options or rules about fleet behaviour (e.g. continue

fishing after some quotas are exhausted) or management scenarios (e.g. all fisheries are stopped when the quota of a particular stock is reached).

$$E_{Fl,Y} = rule(E_{Fl,St1,Y}, E_{Fl,St2,Y}, E_{Fl,St3,Y} \ldots)$$

For example, if one assumes that fishermen continue fishing until the last quota is exhausted, effort by fleet will be set at the maximum across stock-dependent effort by fleet ("max" option). Overquota catches of species which quota were exhausted before this last one, are assumed to be discarded.

$$E(Fl, Y+1) = MAX_{St}[E(Fl, St1, Y+1), E(Fl, St2, Y+1), \ldots] \quad (6)$$

As a contrast, a more conservative option would be to assume that the fleets would stop fishing when the first quota is exhausted, and thus would set their effort at the minimum across stocks ("min" option). Alternatively, management plans for a particular stock could be explored, with the fleets setting their effort at the level for this stock ("stock_name" option). Different rules could also be applied for the various fleets.

The following options are explored:

21) **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.

22) **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.

23) **cod**: All fleets set their effort corresponding to that required to land their quota share of cod, regardless of other catches.

24) **had:** All fleets set their effort corresponding to that required to land their quota share of haddock, regardless of other catches.

25) **whg:** All fleets set their effort corresponding to that required to land their quota share of Whiting, regardless of other catches.

26) **sq_E**: The effort is set equal to the effort in the most recently recorded year for which landings and discard data are available.

All scenarios will be run with two advice approaches, Fmsy transition and management plan. For stocks where a management plan does not exist, the advice according to the latest commission communication on TAC setting is used.

Finally, this resulting effort by fleet is distributed across métiers, and corresponding partial fishing mortality is estimated.

$$E(Fl, m, Y+1) = E(Fl, Y+1) * Effshare(Fl, m, Y+1) \quad (7)$$
$$F(Fl, m, St, Y+1) = q(Fl, m, St, Y+1) * E(Fl, m, Y+1)$$

Partial fishing mortalities are summed by stock, and then used in standard forecast procedures similar to the ones used in the traditional single-species short-term advice. Corresponding landings are estimated and compared with the single-species TAC.

Software used:

The Fcube model has been coded as a method in R (R Development Core Team, 2008), as part of the FLR framework (Kell *et al.*, 2007, www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore 2.2 package, and two forecast methods were used, stf() from the FLAssess (version 1.99–102) and fwd() from the Flash (version 2.0.0) packages. As such, the input parameterisation as well as the stock

projections are made externally using existing methods and packages, while only steps 4 to 6 are internalised in the method, thus keeping full transparency and flexibility in the use of the model.

D. Short–Term Projection methodology

Model used: Overview of software used by WGCSE.

SPECIES	ASSESSMENT	FORECAST
HADDOCK VIIbc, VIIe-k	ASAP (Age-Structured Assessment Programme; NOAA toolbox)	MFDP1a
COD VIIe-k	Age-based analytical assessment (FLR 2.x XSA)	FLR STF
WHITING VIIbc, VIIe-k	Age-based analytical assessment (XSA)	MFDP1a

In the mixed-fisheries runs, all forecasts were done with the same FLR forecasts method (see section C).

For every scenario, the following output is generated per stock:

	Description	Landings	F mult	SSB
Baseline forecast for current year	Applying single species forecast assumptions to last year's data (current year – 1)*	Current yr	Current yr	1st Jan TAC yr
Baseline forecast for TAC year	Applying single species HCRs** to current year results*	TAC yr	TAC yr	1st Jan TAC yr + 1
Current year Fcube results	Applying Fcube to last year's data	Current yr	Current yr	1st Jan TAC yr
Fcube estimate of catches in TAC year	Applying Fcube on current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1
TAC advice results (incl mgt plans)	Applying single species HCRs** to current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1

*** For the Baseline runs, a forecast was run for each stock separately following the same settings as in the ICES single species forecast.**

**** Harvest Control Rules – either from single species management plans or with reference to the F_{MSY} transition approach. Where HCRs according to these approaches were not available values according to the precautionary approach were used.**

The following overview table will be produced to be able to judge the relevance of the different scenarios:

		COD HAD WHG NEPFU16 NEPFU17 NEP19 NEP20-21 NEPFU22 NEPFU18OTH
Current year	Fbar	
	FmultVsF(cur-1)	
	Landings	
	SSB	
Current year+1	Fbar	
	FmultVsF(cur-1)	
	Landings	
	SSB	
Current year+2	SSB	

G. Biological Reference Points

The biological reference points that are used are the same values as referred to in the single stock advisory reports.

H. Other Issues

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