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

10-14 October 2016

Charlottenlund, Denmark

International Council for the Exploration of the Sea

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Contents

Executive summary

The ICES Working Group on Mixed Fisheries Methods [WGMIXFISH-METH] (Chair: Youen Vermard (FR)) met at **Charlottenlund Palace, DTU-Aqua**, **Charlottenlund** 10–14 October 2016 to:

- Review progress on mixed fisheries methodologies, including work under EU projects DISCARDLESS, DrumFish and consider how they might be taken forward and incorporated into the advisory process. In particular, focus should be given to the following priorities:

  - Short term catch forecasting methods, including methods to incorporate data-poor stocks taking account of uncertainties;

  - Incorporation of advice on protected, endangered and threatened (PET) species into mixed fisheries advice;

  - Incorporation of F_{MSY} ranges into forecasting procedure to provide advice which minimizes incompatibility between management advice for multiple stocks exploited in mixed fisheries. A particular attention will be given to the 'optim scenario',

  - Application of methodology to other ICES regions, fisheries and stocks.
- Develop and agree on a work flow to ease the process of MIXFISH-ADVICE for the next years (from data submission by the countries to data exchange with ICES (Stock assessment data, InterCatch data))
- Write a data call for next year MIXFISH-ADVICE for resubmission of a longer time period with homogeneous fleet and métiers strata.
- Develop and/or compile a stock annex of the mixed fisheries methodologies.

In addition to these core issues, the working group also worked on cleaning and putting all the codes under gitlab to make all the work process clean and efficient for the future.

A document summarising the Mixed fisheries problematics in the context of the MAP was built during the working group.

Following some initiatives developed during WGMIXFISH-METH last year, during STECF NSMAP 2015 (2015–05) and in the MYFISH European project, methods to incorporate F_{MSY} ranges to the forecasting procedures were further developed during the Working Group. The approach developed minimizes the differences in catches between the *min* and *max* (or *min* and *sq*) scenarios by searching the appropriate F values for the different stocks. Such an approach allows for reducing the inconsistencies between management advices while staying between the boundaries of the ranges.

1 Introduction

1.1 Background

The mixed fisheries methods working group (WGMIXFISH-METH) was formed in response to the need to further develop how ICES provides mixed fisheries advice and to progress application of methods to areas other than the North Sea, independent of the annual advisory meeting (WGMIXFISH-NS; ICES, 2015). WGMIXFISH-METH met in Charlottenlund 5–9 October 2015 to consider the following issues:

- Develop short term catch forecasting methods, including methods to incorporate data-poor stocks taking account of uncertainties
- Incorporate advice on protected, endangered and threatened (PET) species.
- Incorporate F_{MSY} ranges into forecasting procedures to provide advice which minimizes incompatibilities between management advices for multiple stocks exploited in mixed fisheries.
- Undertake a Principle Component 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.

In addition to these core issues, the working group also considered the inclusion of top predators (seals) in the West of Scotland FCube model and gave some thought on the reformulation of the joined WGMIXFISH/WGCSE data call.

1.2 Terms of Reference

a. Review progress on mixed fisheries methodologies, including work under EU projects DISCARDLESS, DrumFish and consider how they might be taken forward and incorporated into the advisory process. In particular, focus should be given to the following priorities:

   - Short term catch forecasting methods, including methods to incorporate data-poor stocks taking account of uncertainties;

   - Incorporation of advice on protected, endangered and threatened (PET) species into mixed fisheries advice;

   - Incorporation of F_{MSY} ranges into forecasting procedure to provide advice which minimizes incompatibility between management advice for multiple stocks exploited in mixed fisheries. A particular attention will be given to the 'optim scenario',

   - Application of methodology to other ICES regions, fisheries and stocks.

b. Develop and agree on a work flow to ease the process of MIXFISH-ADVICE for the next years (from data submission by the countries to data exchange with ICES (Stock assessment data, InterCatch data)).

c. Write a data call for next year's MIXFISH-ADVICE for resubmission of a longer time period with homogeneous fleet and métiers strata.

d. Develop and/or compile a stock annex of the mixed fisheries methodologies.

1.3 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.

In 2013, WGMIXFISH-METH requested data according to aggregations based on the definitions of the EU Data Collection Framework (DCF) and these terms are used consistently in this report.

1.4 Software

All analyses were conducted using the FLR framework (Kell *et al*. (2007); www.flr-project.org) running with R 3.1. (R Development Core Team, 2008). 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.

The FCube model has been presented and described in Ulrich *et al.* (2008; 2011). 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.

2 Terms of Reference A

2.1 Short term catch forecasting methods, including methods to incorporate data-poor stocks taking account of uncertainties

Stocks without analytical assessments cannot be directly incorporated into advice through the FCube methodology due to the lack of fishing mortality or population estimates, and thus ability to calculate catchability coefficients required for forecasts. Other methods have to be developed to take these stocks into account in the projection. This has been investigated using past CPUEs during previous Working Groups. This year and conjointly with the European Project DRuMFISH, the use of SPICT was investigated.

2.1.1 CPUES

In order to provide some estimate of the potential catch of data-poor stocks, landings or catch estimates have in previous report been provided based on a "CPUE approach". Under the CPUE approach the historic cpue (or lpue) by fleet, métier and stock has been calculated with future catch estimated assuming cpue remains constant for the next two years. This then allows forecasting of catches based on effort projections under each of the FCube scenarios. Catches of the 'CPUE stocks' have been provided as ancillary information in previous working group reports as an exploratory exercise rather than explicitly incorporated in mixed fisheries advice due to uncertainties around future catch rates and unknown robustness of such a simple approach. WGMIXFISH-METH (ICES, 2015) have then explorer the potentiality of using historical time series of CPUEs to take into account variability and uncertainty. However, this approach can only be used if a long time series is available and hardly take into account stock dynamics and status. This approach cannot be used in the FCube algorithm but at posteriori, CPUE stock cannot then drive the system dynamics.

2.1.2 Using SPICT

This year and following some work in development during the European Project DRuMFISH, the use of SPICT to simulate DLS stocks dynamics was investigated. At present, the FCube model involved only stocks of category 1. *Nephrops* evaluated with UnderWater TV are also accounted for in short term forecasts. For DrumFish, progresses are now ongoing to incorporate SPiCT assessment and forecast procedures into the FCube model, both for short-term deterministic and medium-term stochastic projections. Methods are currently being developed to define a framework to incorporate the data-poor stock assessments carried out with SPiCT for these stocks, so that they are also influencing the calculation of the effort. Using SPICT will allow assessing the biological status of the stock using a surplus production model. Estimates of exploitable biomass and fishing mortality will then be used to derive effort for the different scenarios as done for *Nephrops* stocks in FCube. These stocks will then be integrated in the whole process and so their influence in fishing dynamics assessed.

2.2 Incorporation of advice on protected, endangered and threatened (PET) species into mixed fisheries advice.

This Term of reference was not investigated in detail. No new method was investigated as no new data is available and the use of CPUEs, catch limits and uncertainty around catch rate was thought to be the best available for now. This method was developed in the 2015 WGMIXFISH-METHOD report.

2.3 Mixed fisheries and MAP

2.3.1 An example of choke species

Most demersal fish species are caught together in mixed fisheries. This often means that the mix of fish species encountered by the vessel doesn't match-up with the quota shares they have for those stocks. Previously, vessels were able to address this by discarding over-quota catches, but the introduction of the landing obligation to EU fisheries will remove this possibility for stocks subject to TACs. Instead, vessels will be required to stop catching a stock once they have exhausted their quota share for that species. In effect, the first quota share to be exhausted can 'choke-off' fishing possibilities for other stocks caught in the same fishery, hence this is known as the 'choke-species' problem.

This problem only arises in mixed-fisheries and the potential extent of the problem can be illustrated by the difference in landings by stock under the 'max' and 'min' scenarios in an FCube run.

The choke-species problem arises from the mismatch between the mix of species a vessel catches and the quota shares it has for those species. The mix of species that a vessel catches at any one time depends on the spatial and temporal distribution of the different species, which is extremely variable and very difficult to predict on a fine enough scale to be relevant to the operation of fishing vessels. A vessel's quota shares depend on the national shares for the individual stock TACs and the subsequent allocation and quota management process. Stuart Reeves presented some results of a study which looked at the TAC-setting and quota allocation process for North Sea demersal stocks in order to identify key risk factors contributing to the choke risk for these stocks. The risk factors identified included stock state (if a stock is fished above F_{MSY} it is likely that the TAC will be set to reduce fishing mortality and thus increase choke risk) and discarding (stocks with high discard rates are likely to have a high choke risk even if the TAC is increased to account for fish that would previously have been discarded). The results of the study, which was funded by Fisheries Innovation Scotland, are being used to develop a risk framework which will be applied to evaluate the choke risk for all stocks of UK interest.

2.3.2 Mixed-fisheries and MAP

Motivation

The WGMIXFISH METH considered the EU proposal for a multi-annual plan (MAP) for demersal stocks in the North Sea (https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-493-EN-F1-1.PDF) and tried to identify the areas where the group could provide elements of advice on mixed fisheries to facilitate in the application of the plan. Existing single-species management plans consist of a set of rules (harvest control rule, interannual TAC change limitation rules) which clearly state how catch limits should be calculated. On the contrary, the North Sea MAP is intentionally less prescriptive and leaves more room for discussion. The WGMIXFISH-METH focussed on those areas where no concrete formalised rules is defined and tried to identify which type of advice could be provided to give managers a basis for making a decision.

Background

In a mixed fisheries context, where fishing mortality of different species is to some extend correlated due to technical interaction (Figure 2.3.2.1), it is unlikely that all species can be exploited at F_{MSY} at the same time: the F_{MSY} value of different species caught together may correspond to a different fishing efforts and can therefore not be achieved simultaneously (as illustrated on Figure 2.3.2.1).

One of the key features of the plan is the use of range of values for F_{MSY}, instead of point values. These were introduced to allow for more flexibility in the management system and overcome the problem of setting single-stock TAC based on F_{MSY} which are incompatible due to technical interactions.

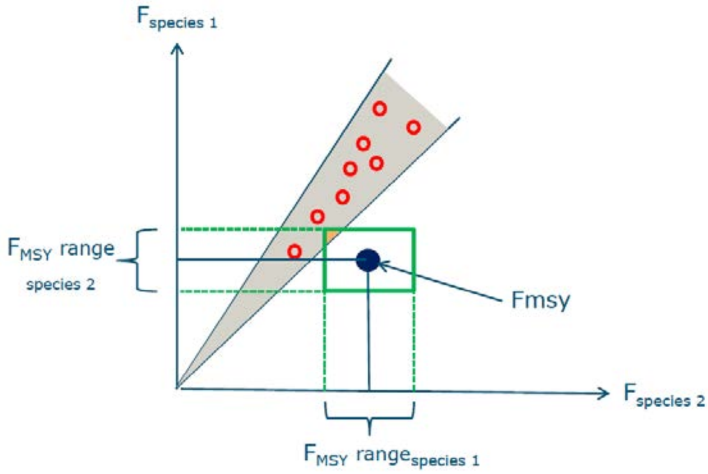

Figure 2.3.2.1 Schematic representation of technical interactions between two species and illustration of how F_{MSY} ranges can allow to achieve MSY simultaneously for both species. Historical fishing mortality values for both species (red circles) plotted against each other define the area of technical interactions (grey area). The combined F_{MSY} point estimate (blue dots) is outside the area of the technical interactions and cannot therefore be achieve simultaneously for both species. By using the F_{MSY} ranges (green dashed lines) an area of fishing mortalities being both within the F_{MSY} ranges for both species and in the area of possible combine fishing mortalities can be achieved (orange triangle).

Main elements in the North Sea MAP proposal relevant for WGMIXFISH

- Scope

The plan will apply to demersal stocks exploited in the EU waters of the North Sea (areas 2a, 3a and 4). The proposal also specifies that stocks with a distribution extending outside EU waters in the North Sea should also be managed according to the plan. This includes North Sea stocks distributed not only in EU water but also in Norwegian waters. This also includes stocks present in the North Sea but distributed also in other EU regions (e.g. North Western Waters, or even South Western Waters).

Contrasting situation are observed among those straddling stocks with regard to the proportion of the TAC allocated to North Sea areas (see table below). Most of the TAC for saithe or haddock is allocated to the North Sea. In such cases, it can be anticipated that the management of those stocks will fall under the North Sea MAP. However for stocks like angler fish or megrim, the distribution of the TAC between the North Sea and the North Western Waters is more balanced. In this case it is unclear under which MAP those stocks should be managed. Finally, for other stocks like hake, only a small proportion of the TAC is allocated to the North Sea, and it is more likely that management targets for this stock are defined under MAP from other regions.

Straddling stocks included in the North Sea MAP (and proportion of the TAC in the North Sea area)

Species	Share of the 2016 TAC in the North Sea
Anglerfish	(2/3 North Sea, 1/3 western waters)
Saithe	(90% North Sea, 10% western waters)
Megrim	(1/3 North Sea, 2/3 western waters)
(northern) Hake,	4% in the North Sea
Haddock	85% for area IV
Seabass not included in the plan	

Mixed fisheries implications:

Setting management targets in a mixed fisheries context for these straddling stocks represents a challenge. The North Sea plan allows for some flexibility in setting the management targets in order to accommodate for potential mixed fisheries problems (but is it not known yet if it will be the case for other regional plans). However the need to increase or decrease the Ftarget for a given stock may differ across management regions, if the mixed fisheries constraints regarding the consumption of the quotas are different (e.g. quota limiting fleets effort in one area, but pulling it up in another area). A potential solution to minimise mixed fisheries problems in both areas would consist in introducing flexibility in the quota allocation key between areas.

- Stock categories

The different demersal fish and *Nephrops* stocks included in the plan are classified in 7 groups, which are defined based on the availability of reference points and on the current type of management.

Mixed fisheries implications:

Groups 1 and 2 are (respectively fish and *Nephrops*) stocks with F_{MSY} ranges. The plan foresees that these ranges could be used to solve mixed fisheries problems. Work is currently carried out to develop assessment methods for data poor stocks (current classified in group 3 and higher), which could potentially result in the definition of F_{MSY} ranges for these data poor stocks. The plan does not currently contain a provision for updating either the group to which a stock belong, or the value of the reference points after new values was been accepted during a benchmark. The ICES MIXFISH group advises that the target and conservation reference points used in the MAP should be updated after each benchmark carried out by ICES, and the grouping of the stocks modified accordingly when necessary.

- Management targets

For stocks in groups 1 and 2 (respectively, demersal fish and *Nephrops* stocks for which F_{MSY} ranges are defined), and provided that a stock is above the conservation reference point (MSY $B_{trigger}$), catch limits should be based on target fishing mortality values taken between the lower bound of the F_{MSY} range, F_{low}, and the point estimate F_{MSY}. Under certain circumstances defined in the proposal, the target fishing mortality can be set higher, between the F_{MSY} point estimate and the upper bound of the range, F_{upper}. One of the situations where the plan allows for this to happen is when using an Ftarget in the upper part of the range for some of the stocks would contribute to reduce the imbalance between single-stock TACs resulting from mixed fisheries interactions.

For stocks in other groups, catch limits should be based either on F_{MSY} when it is defined, or on the precautionary approach.

<u>Mixed fisheries implications:</u>

The definition of the fishing mortality management targets is a key part of the plan for which the ICES mixed fisheries advice could be the basis for decision making. The plan explicitly gives freedom in the target values to be used by introducing the ranges, so that negative consequences of mixed fisheries interactions, such as over-quota discarding or loss of fishing opportunities, can be minimised. The following sections in this report (sections 2.3.3–2.3.5) present a number of approaches on how the ranges can be used in the context of this plan and their potential benefits in term of reduction of mixed fisheries problems.

It should be noted however that using the ranges for a given stock in group 1 or 2 is no longer possible if the stock falls below MSY $B_{trigger}$. In other words, flexibility is not allowed precisely when it is the most needed (because the quotas become limiting). This transition from a flexible Ftarget setting rule to a strict one when the stock is decreasing may increase the likelihood of such stocks to become choke species. There is a trade-off between rapid rebuilding to levels producing maximum sustainable yields (SSB > MSY $B_{trigger}$) and moderation of negative mixed fisheries effects. This trade-off could be studied using mixed fisheries simulation.

Another weakness of the plan is that there is currently no mechanism to introduce flexibility for setting catch limits for stocks not in group 1 or 2. Most of the potential choke species (hake, turbot) are in group 3, and the MAP is not likely to provide any solution in those cases.

2.3.3 Using simple rules

The simplest rule applied in the FCube framework to take advantages of the F_{MSY} ranges to cope with single stock advice inconsistencies was called the "balanced" strategy. This strategy consisted in setting the TAC based on F_{MSYlow}, the lower bound of the F_{MSY} range, for species currently exploited at $F_{bar} < F_{MSYlow}$, using the upper bound of the range, $F_{MSYhigh}$, for species currently exploited at $F_{bar} > F_{MSYhigh}$, and the point estimate F_{MSY} for species currently at $F_{MSYlow} \leq F_{bar} \leq F_{MSYhigh}$.

An example of these rules has been implemented and proposed last year.

2.3.4 Optim scenario in FCube

The method and its potential usefulness to give mixed fisheries advice for the MAP

The development of the optimisation procedure was one of the ToRs of the 2015 WGMIXFISH METH and published recently (Ulrich *et al*. 2016). The method aims at finding the combination of Ftarget within the allowed ranges for stocks in groups 1 and 2 which would result in smallest possible incompatibilities between single-species TACs. The incompatibilities are quantified as the sum across stocks of the difference between the forecasted landings in the "max" and in the "min" scenario in FCube. Minimising this difference concretely means that the single-stock TACs are set so that the incentive to overshoot the TACs is as small as possible.

This optimisation procedure can be used to formulate a new type of mixed fisheries advice that ICES could deliver to help implement the North Sea MAP:

- Firstly, advice can be given on the target fishing mortality and catch limits per stock. The current mixed fisheries advice only shows landing forecasts for the current management targets. The optimisation provides an objective method to set the Ftarget values within the authorised ranges, so that incompatibility between the resulting TACs are minimised. One of the objectives of the plan is to contribute to the good implementation of landing obligation by reducing over-quota discarding. By minimising the difference between the "max" and the "min" FCube scenarios, the optimisation procedure effectively minimises the incentive to continue fishing when the first quota is reached.
- Secondly, the optimisation procedure can be used to quantify the potential costs and benefits of setting F target values for some stocks in the upper part of the F_{MSY} range. Based on this information, managers can decide whether it is justified to apply an F target between F_{MSY} and F_{upper}.

Recent technical developments in the optimisation procedure

The drawback of this algorithm is the time taken by the simulations (several hours). In order to speed the procedure and making it more flexible, the parallelisation of the code (running several FCube simulations with several sets of F in parallel using computational facilities) have been investigated and implemented during the group. Some computation problems are still to be solved but it is expected to have the code running in the coming month and available on github.

Illustration of the information provided by the optimisation procedure which can be used in mixed fisheries advice

- Setting Ftarget values and visualising trade-offs

An illustration of the type of advice which could be given using the optimisation procedure is shown here, using last year's (assessment year 2015) mixed fisheries data. The optimisation procedure is run on the lower part of the F_{MSY} ranges, i.e. by allowing Ftarget to take values between F_{lower} and F_{MSY} (default option in the MAP) and the resulting Ftargets, TACs and forecasted landings can be compared with a situation where the F_{MSY} value are used.

The main output of the optimisation procedure, which can be given as advice, is the set of Ftarget values for each stock, as shown on Figure 2.3.4.1 In this example (for the opitmisation run using the lower part of the range), the optimal Ftarget values are close to the F_{lower} value for the stocks with the largest TACs (haddock and plaice).

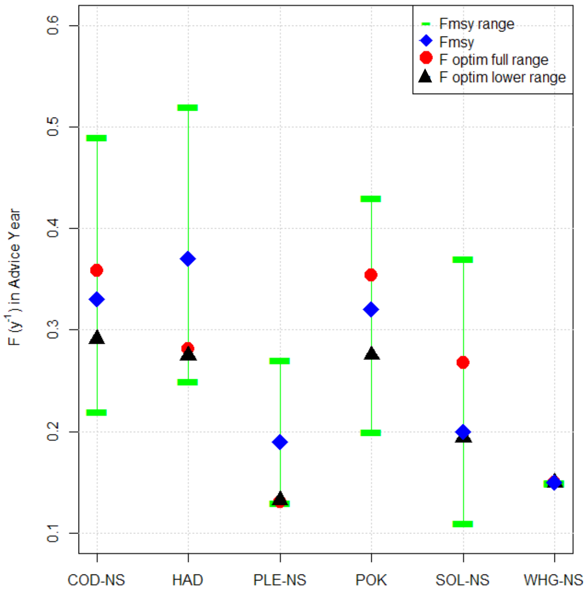

Figure 2.3.4.1 Fishing mortality targets resulting from the optimisation procedure using the lower part of the ranges (black triangles) and using the full FMSY ranges (red dots). Ranges for FMSY are depicted as green intervals) and the FMSY value as a blue diamond.

The costs and benefits of using the optimisation for setting the Ftarget instead of simply using the FMSY values can be illustrated by looking at the difference in the resulting landings forecasted for the FCube scenario "min" (which is the most likely scenario in a situation where the landing obligation is strictly implemented). For instance, Figure 2.3.4.2 shows that if the optimisation procedure is used to set the Ftarget values within the lower part of the FMSY ranges, the resulting landings for all stocks would be lower than if the FMSY value is used as Ftarget. This is consistent with the fact that all Ftargets are set lower than FMSY (Figure 2.3.4.1). The optimisation procedure however results is smaller incompatibilities between TACs, as illustrated by a decrease by a half of the total quota over-shoot in a FCube scenario "max" and quota under-shoot in a FCube scenario "min" (Figure 2.3.4.3).

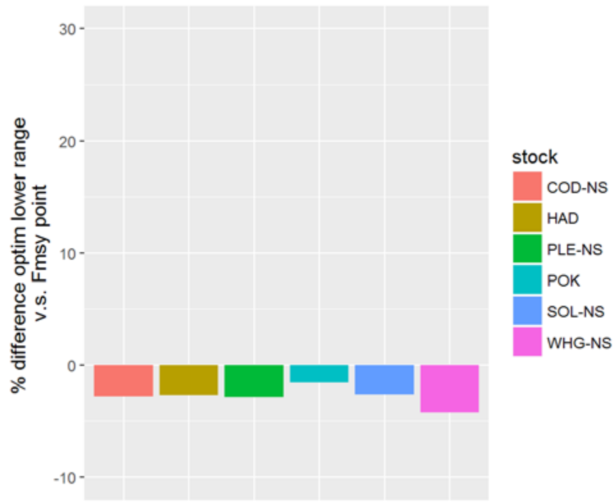

Figure 2.3.4.2 Differences in the forecasted landings for the FCube scenario "min" when the TACs are set using the optimisation procedure in the lower part of the F_{MSY} ranges and when the TACs are set based on the F_{MSY} values.

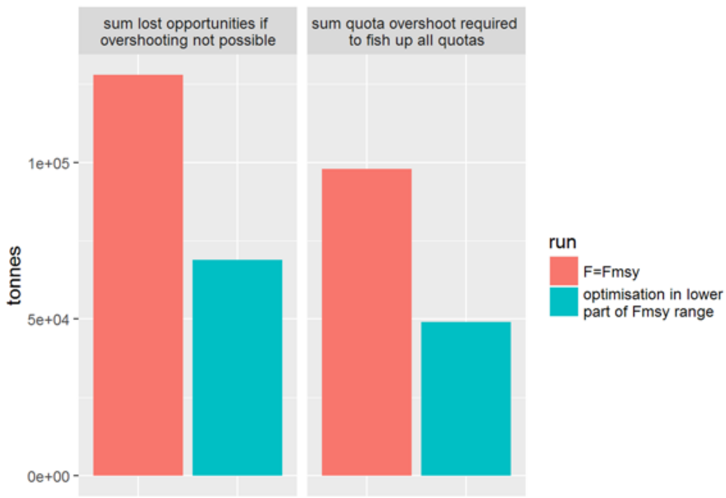

Figure 2.3.4.3 Comparison of magnitude of the TAC incompatibilities when TACs are set using the F_{MSY} value (orange) or using the optimisation procedure in the lower part of the F_{MSY} ranges (blue). Incompatibilities are measured as the sum across stocks of the quota under-shoot in the FCube scenario "min" (left), and the sum of the quota over-shoot in the scenario "max" (right).

- Support for a decision on using the upper part of F_{MSY} ranges

In a similar manner, in order to assess whether the upper part of the ranges should be used, the optimisation procedure can be run using the whole F_{MSY} ranges, and the resulting Ftargets, TACs and forecasted landings can be compared with the results of the optimisation using only the lower part of the F_{MSY} ranges.

In the case of the year 2015 taken here as example, the optimisation using the full F_{MSY} ranges indicates that Ftarget should be taken higher than F_{MSY} for cod, saithe and plaice (Figure 2.3.4.1). By using a higher Ftarget on these limiting stocks, the effort of the fleets globally increases in the FCube scenario "min", resulting in landings for all stocks higher by 20 to 30% (Figure 2.3.4.4). In addition, this also allows for a further decrease by one half of the quota incompatibilities (Figure 2.3.4.5).

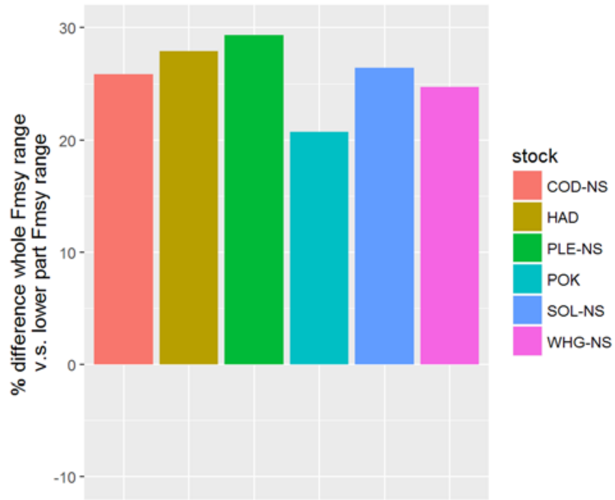

Figure 2.3.4.4 Differences in the forecasted landings for the FCube scenario "min" when the optimisation procedure is using the whole F_{MSY} ranges and when it is using only the lower part.

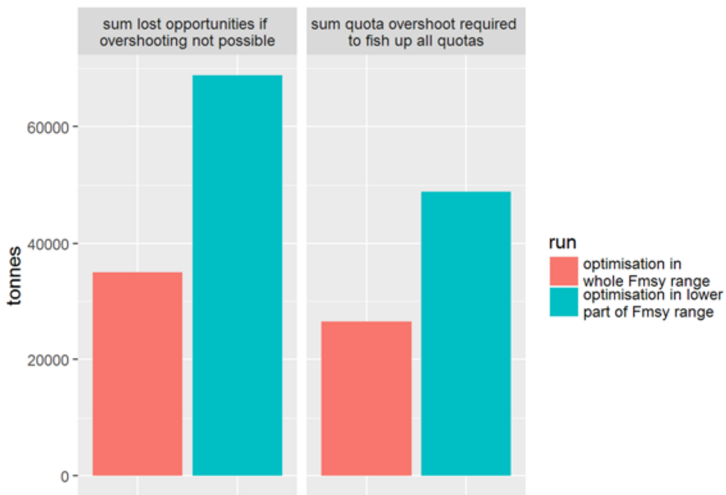

Figure 2.3.4.5 Comparison of magnitude of the TAC incompatibilities when TACs are set using the optimisation procedure in the lower part of the F_{MSY} ranges (blue) or in the full F_{MSY} ranges (orange). Incompatibilities are measured as the sum across stocks of the quota under-shoot in the FCube scenario "min" (left), and the sum of the quota over-shoot in the scenario "max" (right).

2.3.5 Multi-stock HCR in FLBEYA

Working Document presented to the ICES WKMIXFISH working group, October 2016.

A multi-stock harvest control rule as a step towards an ecosystem based fisheries management

Dorleta Garcia, Raúl Prellezo, Agurtzane Urtizberea, Sonia Sanchez

At present TAC advice of commercially exploited stocks is given in a single stock basis. In the light of ecosystem based fisheries management (EBFM) the need to move towards a holistic approach has been largely acknowledged by scientists. In addition, the recently introduced landing obligation policy requires consistent multi-stock TAC advice. In this context, in 2015, the European Commission through the STECF launched several working groups to investigate if the use of fishing mortality ranges to generate TAC advice could improve the use of fishing opportunities in mixed-fisheries. In this study we propose a multi-stock HCR based on the rule used by ICES in the MSY framework. The HCR generates the TACs using the highest possible fishing mortalities within the ranges proposed by the STECF. But it is subject to two restrictions. One, the biomasses should be maintained above the reference levels. And two, the advice fishing mortality vector is obtained multiplying the statu quo fishing mortality vector by a scalar. The first restriction assures the biological sustainability of the stocks and the second the consistency of the single stock TACs in a mixed-fishery context. In order to evaluate the HCR, we apply it to the Iberian Waters Demersal fishery and compare its bio-economic performance with the performance of the management scenarios tested by the STECF in 2015. The HCR makes a more adequate use of the existing fishing opportunities while biomasses are maintained above reference levels. It represents a step forward on the route to operationalize the EBFM.

Keywords: ecosystem based fishery management, harvest control rule, landing obligation, mixed-fisheries.

2.3.5.1 Introduction

In the light of ecosystem based fisheries management (EBFM) (Pikitch *et al.*, 2004) the need to move towards a holistic approach in fisheries management has been largely acknowledged by scientists. However the TAC advice of commercially exploited stocks is still given in single stocks basis. On the other hand, stocks are usually caught simultaneously by fleets (the so called mixed fisheries) which cannot discriminate among stocks at the time of fishing. In this framework, the mismatch between the catch profiles of the fleets and the TAC advices produce an incentive to generate overquota discards (Ulrich *et al.*, 2011). Besides, the Landing Obligation (LO) policy introduced in the last reform of Common Fisheries Policy the consistency among single stock TAC advice has become even more important as the fishermen should stop fishing when one of their quotas is exhausted. The lack of consistency among TACs could produce the feeling that significant fishing opportunities are being lost under landing obligation.

Since 2008 the WKMIXFISH ICES working group gives a multi-stock TAC advice for the North Sea stocks taking into account the stock interactions at fleet and métier level. The advice is obtained using the FCube method (Ulrich *et al*., 2011). This method uses the output of single stock assessments to explore the consequences of different management alternatives based on the single stock TAC advice and using the catch information at métier and fleet level.

The multi-stock harvest control rule presented in this paper emerged from the work done by the STECF in 2015 in relation to the fishing mortality ranges (STECF, 2015). In the simulations carried out by the STECF, the HCRs used, employed the upper or lower bounds of the ranges for all the stocks at the same time. If in the real world the advice was given using Fupp for all the stocks it would produce false expectations to fishermen. Under no landing obligation, it will produce large discards of restrictive stocks and under the landing obligation it will produce the feeling that fishing opportunities of non-restrictive stocks were being lost. Hence, it is important to use ranges to conciliate single stock advice and to produce TAC advice that can be achieved simultaneously for all the stocks.

The objective of the multi-stock harvest control rule presented here is to produce consistent TAC advice, within the fishing mortality ranges, while maximizing the use of fishing opportunities. This HCR only uses output data from stock assessment models. To illustrate the use of the HCR, it was applied to the Iberian Waters Demersal Fishery System. First it was used to produce TAC advice for 2017 using the data from last assessment working group. Then, it was tested within the multi-stock and multi-fleet bio-economic simulation framework FLBEIA (García *et al*., 2016; Prellezo *et al*., 2016). The bio-economic performance of this HCR was compared with the performance of the current single stock MSY approach used by ICES to produce TAC advice.

2.3.5.2 Material and Methods

2.3.5.2.1 The case Study

2.3.5.2.2 The area

The Atlantic Iberian waters (ICES Divisions 8.c and 9.a) include three areas with different oceanographic characteristics: Gulf of Cadiz with Mediterranean influence, Atlantic front with high upwelling process, and Cantabrian Sea (south area of Bay of Biscay) with transition between subtropical and sub-polar areas. Politically, the Atlantic Iberian waters are compounded by the Spanish and Portuguese national waters. The case study presented here of the Iberian waters only considers the Atlantic front and the Cantabrian Sea.

However, from an ecological point of view, the narrowness of the Iberian continental shelf provides a common spatial dimension where different fleets share a variety of fishing resources.

2.3.5.2.3 The fleets

Vessels that operate in Atlantic Iberian waters belong to the national fleets of Spain and Portugal. Therefore, the vessels fishing Iberian stocks (ICES Divisions 8.c and 9.a) have to apply for a fishing license to operate in the respective national waters. Both countries classify their national vessels in fleet categories depending on the gear type (trawl, purse seine, gillnet or longline), and both countries leave an independent classification group for the small-scale fleet.

These fleets operate on a narrow continental shelf where they exploit a variety of fishing resources by using different type of gears (trawl, gillnet, long lines), forming a common demersal mixed-fisheries fleet. Although recent changes in fishing strategies and gears design have led some traditional demersal fleets to also exploit pelagic species, is not simple the combined management of demersal and pelagic stocks. On the one hand, most of the landings of pelagic stocks are made by fleets (purse seine, hand lines) without any effect on demersal stocks.

On the shake of this report and according to the last data available, the fishery is formed by 2524 vessels grouped into five fleets segments. From Spain two fleet segments were considered, demersal trawlers (DTS_SP) and non trawlers (NTR_SP) which include gillnetters and long-liners. From Portugal two segments were taken, demersal trawlers (DTS_PT) and polyvalent artisanal fleet (PGP_PT).

2.3.5.2.4 The stocks

The multispecies characteristic of the fishery analyzed creates an important complexity in terms of the interaction between the advice and its implementation. Things like fleet behavior, discards behavior and the individual computation of the reference points generate a complex system. When simulating, not all the stocks can be considered explicitly simply because the quality of data available differs. This complexity reduces the number of explicit stocks that can be consider, however we think that there is an important coverage of them (aprox. 35 % of total).

In this sense eight stocks are included explicitly in the model but they are treated differently:

Hake (*Merluccius merluccius*), Megrim (*Lepidorhombus whiffiagonis*), Four Spot megrim (*Lepidorhombus boscii*), White Anglerfish (*Lophius piscatorius*), are demersal stocks which distribution coincides with the area analyzed. All of them are assessed by ICES and have analytical assessments. In terms of the simulation, these stocks have been projected using an age structured exponential survival model together with a stock-recruitment model to simulate the new individuals that incorporate to the fishery. For all the stocks a deterministic segmented regression model has been used and uncertainty has been introduced multiplying a lognormal error to the stock recruitment point estimate. This error has a median equal to one and coefficient of variation obtained in the historical stock recruitment model fit.

Southern Horse Mackerel (*Trachurus trachurus*), is a pelagic species and its distribution coincides with the study area. It is assessed by ICES and has an analytical assessment. In terms of the projection of the population the same procedure as explained above has been used.

Western Horse Mackerel (*Trachurus trachurus*), is a pelagic stock which is distributed along the northeast continental shelf of Europe from the Bay of Biscay to Norway. In terms of its projection throughout the simulation their abundance has been maintained constant and equal to the 2010–2012 mean level.

Mackerel (*Scomber scombrus),* and Blue Whiting (*Micromesistius poutassou*) are widely distributed pelagic stocks. In terms of their projection throughout the simulation their abundance has been maintained constant and equal to the 2010–2012 mean level

The total catches of the Iberian Waters Demersal fleets of Mackerel and Blue Whiting represent a 3% of the total catches of these stocks and around 16% for Western Horse Mackerel. However, they could play an important role if we consider the Landing Obligation applied to them under the new CFP. This effect comes from the low quotas available to the fleets analyzed that could cause what is named as choke effects. That is, these species could constraint the total effort that these fleets could exert.

These eight stocks cover more than 35% of total catch and income for each of the fleets. However, to perform an economic analysis of the fleets all the income has to be considered. For doing so, a dummy stock has been introduced into the model (denoted as OTH) including all these other incomes. The catches and income coming from this dummy stock is métier dependent, that is, each métier will have different catches of this stock as well as a different average price.

2.3.5.3 Data used

Stock data used in the conditioning of the model has been taken from ICES assessment working groups. The outputs of these assessments are used directly to condition the model.

Catch and effort data by fleet and métier for years 2010 to 2012 was compiled by the national institutes, IEO (Spain) and IPMA (Portugal) in the framework of GEPETO project.

The fleet segment is defined as a group of vessels with the same predominant fishing gear during the year.

Métiers are defined as groups of fishing operations with the same fishing gear.

Fixed costs are given at fleet level and variable costs at métier level. The costs have been obtained from the Annual Economic Report (STECF, 2016). To adapt these values to the specific conditioning of the case study, the economic figures have been weighted by the proportion of vessels that each segment has and then converted into weighted averages of the fleets.

2.3.5.4 Simulation Model: FLBEIA

FLBEIA is a simulation Bio Economic Model (BEM) coupled in the economic and biological dimensions, it is developed in R using FLR libraries (García *et al.*, 2016; Prellezo *et al.*, 2016). FLBEIA follows the MSE approach, which is widely used in fisheries management to analyze the performance of management strategies against predefined management objectives, by means of simulation before they are put in place. It consists of simulating the fish stocks and the fleets that exploit them together with the management procedure. The goal is to analyze the performance of different management strategies and identify those strategies that are robust to the uncertainties considered.

The simulation algorithm is divided into two blocks, the Operating Model (OM) and the Management Procedure Model (MPM). In FLBEIA the OM is made up of the fish stocks, the fleets, the covariates and their interactions. The MPM describes the management process and is formed by the observation, assessment and management advice models. The stocks can be age structured or aggregated in biomass and there are no trophic interactions. Fleet activity is divided into métiers where métiers are defined as trips within a fleet that share the same characteristics in terms of gear used, fishing area and catch profiles.

The stocks can be age structured or aggregated in biomass. The interaction between fish population and catch is done in biomass and the relationship between catch and effort is based on a Cobb Douglas production mode at age level.

The stochasticity in the model is introduced using Monte Carlo simulation and can be introduced in any model parameter. In the simulations it has been introduced only in the biological side (in the stock recruitment relationship) and a Monte Carlo simulation has been performed with 200 iterations. The coupled characteristic of FLBEIA implies that this uncertainty is spread through all the remaining dimensions of the model (economic and social).

To couple the biological and economic side a catch by fleet has to be generated. This catch is generated using a Cobb Douglas production with constant return to scale. Historical catchability (2010–2012) has been calculated using historical biomass and effort data to parameterize this catch function.

In terms of the effort share, it is considered to be constant along métiers and equal to 2012, 2014 and 2015 years average. Year 2013 was not used because the data is not available,

Total effort is calculated in each step based on the quota share of the stocks caught by the fleet. First the total effort that corresponds with the catch quota of each of the stocks is calculated. The, as landing obligation is in place since the beginning of the simulation, the total effort is set equal to the lowest one in order to avoid over-quota discarding.

Capital dynamics are modelled through changes in fleet's capacity. Capital vary according to a model that relates the investment and disinvestment in new vessels with the ratio between revenue and break even revenue, that is the amount of revenue needed to cover both fixed and variable costs. The annual investment for each fleet is determined by the possible maximum investment multiplied but the profit share that will go to the investment itself; however, investment in new vessels will only occur if the operational days of existing vessels are equal to maximum days.

2.3.5.5 The Multi-Stock HCR

The HCR should fulfill the following properties:

1. Produces compatible catch advice among the stocks.
2. Takes the most out of fishing opportunities.
3. Results in fishing mortality levels compatible with MSY ranges.

1. Compatible catch advice

If we assume a linear relationship between fishing mortality and Effort, with catchability, q, as proportionality parameter i.e F = q*Effort, in order to have compatible fishing mortality advice, it is enough to multiply the current fishing mortalities, i.e. the status quo fishing mortalities F_{sq}, by the same parameter, μ. Mathematically:

$$\mathrm{Fadv}_{st} = \mu \cdot \mathrm{Fsq}_{st}$$

Where st denotes the subscript for stock and F_{adv} the fishing mortality that will correspond with the TAC advice. Now the problem is how to define μ in order to fulfill the second and third properties.

2. *Uses most out of fishing opportunities*

If the F_{advice} for all the stocks is equal or higher than the corresponding F_{msy} we assure that all fishing opportunities corresponding with MSY framework are being used. Then, we need to define μ_0 such that:

$$\text{Fadv}_{st} = \mu_0 \cdot \text{Fsq}_{st} = \max_{st}\left(\frac{\text{Fmsy}_{st}}{\text{Fsq}_{st}}\right) \cdot \text{Fsq}_{st}$$

3. *Compatible with MSY ranges*

The F advice in the previous step could be higher than the upper bound of the fishing mortality range of some stocks. Hence we apply a second multiplier to ensure that F_{advice} falls within the ranges for all the stocks, i.e.:

If for any st :

$$F\text{adv}_{st} = \begin{cases} \text{Fadv}_{0,st} = \mu_0 \cdot \text{Fsq}_{st} & \text{if} \quad \mu_0 \cdot \text{Fsq}_{st} \leq F\text{upp}_{st} \text{ for all } st, \\ \mu_1 \cdot \mu_0 \cdot \text{Fsq}_{st} = \min_{st}\left(\frac{\text{Fupp}_{st}}{\text{Fadv}_{0,st}}\right) \cdot \mu_0 \cdot \text{Fsq}_{st} & \text{if for any } st \quad \mu_0 \cdot \text{Fsq}_{st} > F\text{upp}_{st} \end{cases}.$$

where *Fupp* is the upper bound of fishing mortality range.

2.3.5.6 The Management Procedure

In this particular simulation, it has been assumed that the stock status is known without error. But there is a two year time lag between assessment and management implantation as it happens in reality in the management of these stocks.

From 2016, the real TACs have been used instead of using a Harvest Control Rule (HCR) to produce them.

Four alternative management strategies were tested depending on the HCR used to produce the TAC advice together with the implementation or not of the LO policy:

1. **ices**: The HCR used by ICEs in the MSY framework and no LO.
2. **mshcr**: The multi-stock HCR and no LO.
3. **ices_lo**: The HCR used by ICES in the MSY framework and LO.
4. **mshcr_lo**: The multi-stock HCR and LO.

2.3.5.7 The Management Procedure

The comparison of scenarios was done in pairs, the two scenarios without LO on the one hand and the scenarios with LO in the other hand. Two things were compared to evaluate the performance of the HCR:

- If the HCR was able to bring the stocks to MSY levels by 2020.
- The use of fishing opportunities. The following indicator was defined to measure their use:

$$I = \sum_{st} \left(\frac{TAC_{st} - C_{st}}{TAC_{st}} \right)^2$$

The lower the value of the indicator I. the bigger the use of fishing opportunities.

We ran the simulations from 2016 to 2025 using 500 independent iterations run in parallel.

2.3.5.8 Results

2.3.5.8.1 TAC advice for 2017.

The multi-stock HCR was applied to the last assessment results (ICES, 2016) to produce the TAC advice for 2017 which would be obtained using this HCR instead of the ICES MSY approach HCR.

The final and intermediate F multipliers are shown in Table 3. While the implementation of MSY supposed an increment of 48% in the fishing mortality of F_{MSY}, for the rest of the stocks it supposed a decrease of at least 31% (first row in Table 3). If we want to be within F ranges using the most of fishing opportunities the bigger multiplier in the first row of Table 3 should be multiplied by 0.47 (second row Table 3). Finally, the Fsq-s should be decreased in a 31% (multiplier = 0.69) to be within the fishing mortality ranges for all the stocks.

Table 3 Intermediate fishing mortality multipliers obtained in the multi-stock HCR. The final multiplier used to calculate F_{adv} is the multiplier in the third row.

	HKE	LDB	MEG	MON
$\frac{Fmsy_{st}}{Fsq_{st}}$	0.48	0.69	0.52	1.48
$\frac{Fupp_{st}}{Fadv_{0,st}}$	0.47	0.71	0.54	1.32
$\mu_0 \cdot \mu_1$	0.69	0.69	0.69	0.69

The F-advice for 2017 obtained with the multi-stock HCR is shown in Table 4, together with the F status quo and the fishing mortalities obtained in intermediate step. The first step (second row) supposed to be well above the upper limit in the case of Hake. Finally the multi-stock HCR resulted in an upper limit advice for Hake, F_{MSY} advice for Four-Spot megrim, advice between F_{MSY} and upper limit for megrim and advice below lower limit for monkfish (Table 4 and Figure 1).

Table 4 Fishing mortalities obtained in the intermediate steps of the multi-stock HCR. F_{adv} is in the third row.

	HKE	LDB	MEG	MON
F_{sq}	0.52	0.36	0.28	0.21
$\mathrm{Fadv}_0 = \mu_0 \cdot \mathrm{Fsq}_{st} = \max_{st}\left(\frac{\mathrm{Fmsy}_{st}}{\mathrm{Fsq}_{st}}\right) \cdot \mathrm{Fsq}_{st}$	0.77	0.41	0.54	0.31
$\mathrm{Fadv} = \min_{st}\left(\frac{\mathrm{Fupp}_{st}}{\mathrm{Fadv}_{0,st}}\right) \cdot \mu_0 \cdot \mathrm{Fsq}_{st}$	0.36	0.19	0.25	0.15

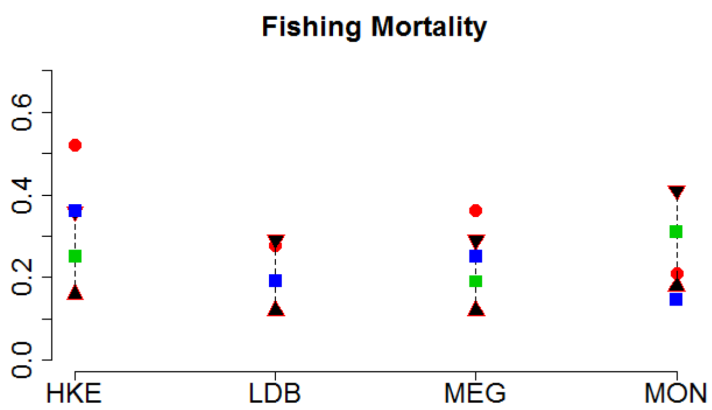

Figure 1 Fishing mortality ranges (black triangles and dashed lines), F_{MSY} (green squares), F_{sq} (red circles) and F_{adv} using multi-stock HCR (blue squares) for 2017.

2.3.5.8.2 MSE simulations

SSB time series together with 90% confident intervals are shown in Figure 2. The SSB was well above the trigger point for all the stocks in the whole simulation.

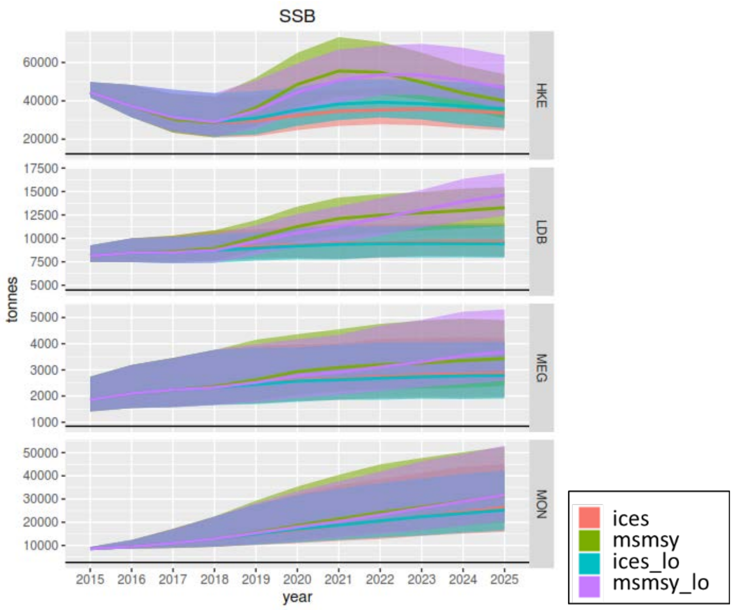

Figure 2 SSB time series for the demersal stocks. The solid line correspond with the median of the distribution and the shaded area represents the 90% confidence interval. The horizontal black line corresponds with the $B_{trigger}$.

Figure 3 presents the fishing mortalities obtained in the OM in year 2020. 'ices' HCR was not able to bring Hake's fishing mortality below the target in none of the scenarios. Furthermore, in the scenario without the LO the fishing mortality was above upper limit. For the rest of the stocks, fishing mortality was equal or lower that the target. Multi-stock produced similar results with and without the LO for all the stocks. The fishing mortalities were all below the target or even below the lower bound in the case of megrim and monkfish.

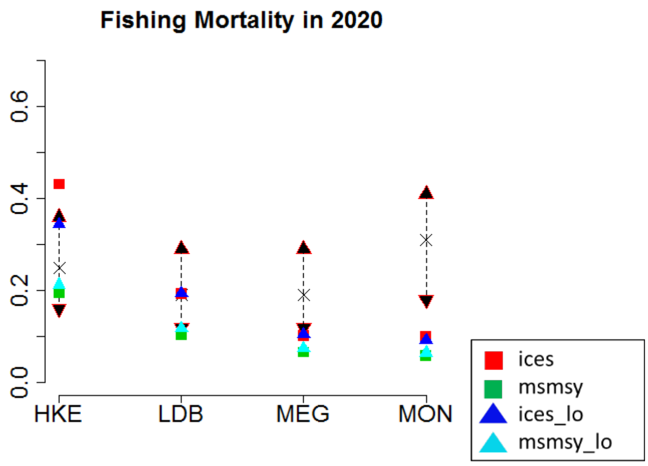

Figure 3 Fishing mortality ranges (black triangles and dashed lines) and F_{MSY} (crosses). F_{sq} (red squares) and F_{adv} using multi-stock HCR (blue squares) for 2017.

Figure 4 shows the time series of the indicator defined in Section 3.1.2. Without landing obligation, red and green lines, the performance of the multi-stock HCR was always better. In fact the performance of the ices HCR got worsen over the years. Under the landing obligation, from 2018 onwards, the performance of the multi-stock HCR was significantly better until 2020. Afterwards the performance of both HCRs was quite similar.

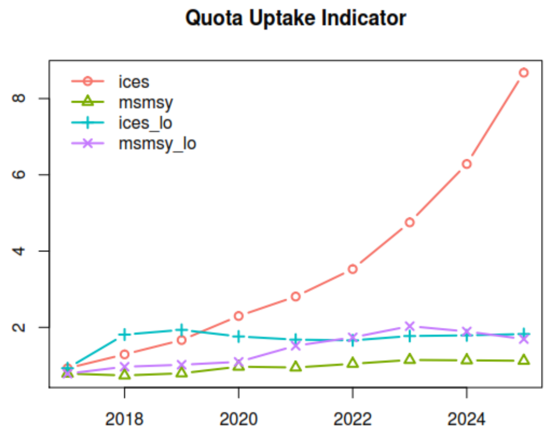

Figure 4 Quota use indicator time series in the four scenarios.

At stock level the performance of the HCRs differed from stock to stock and implementation or not of the landing obligation (Figure 5). But for a given stock the pattern was quite similar along the years. For example, for Hake, multi-stock HCR performed better without the landing obligation but worst without it and the same happens in both years 2018 and 2025. In contrast for Megrim or Monkfish multi-stock HCR was always better.

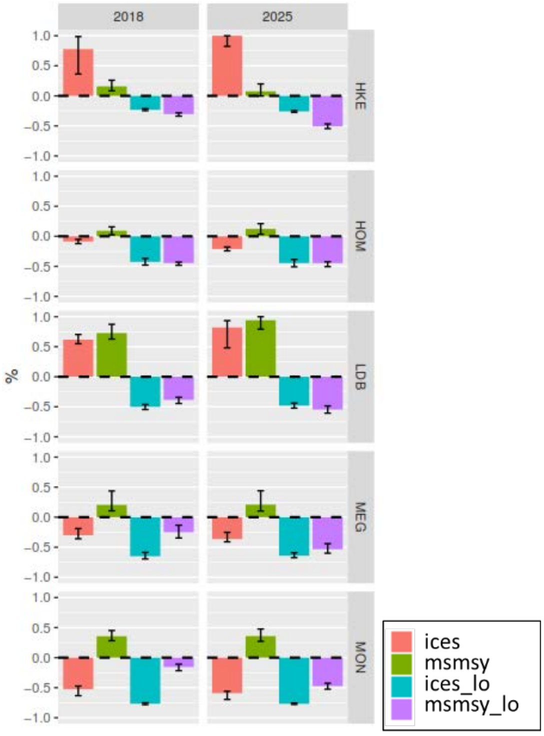

Figure 5 Quota uptake for each stock in years 2018 and 2025. Positive bars indicate that the TAC was overshot and negative bars that it was not exhausted. No bar indicates that the TAC was exhausted completely.

Figure 6 shows the quota use indicator at fleet level. The indicator for gillnetters and trawlers was similar to the overall one, significant differences under no landing obligation but similar results without it. However for Longliners there were big differences. The implementation or not of the landing obligation did not have a big impact in the indicator. The quota use was quite good for multi-stock HCR and it was worst for ices HCR.

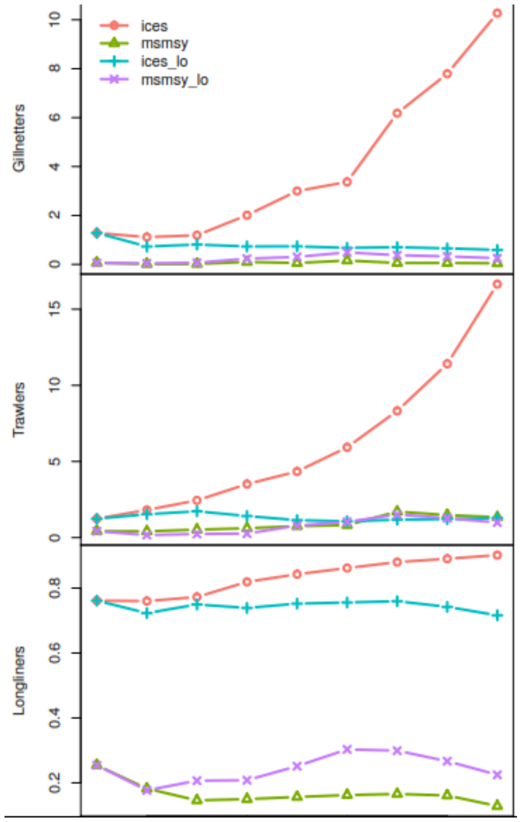

Figure 6 Quota uptake indicator time series at fleet level.

Gillnetters and trawlers have a high overquota of Hake in 'ices' scenario without landing obligation and in contrast longliners consumed exactly its quota in all the scenarios (Figure 7). For the rest of the stocks in general there was a surplus of quota which decreased with the use of multi-stock harvest control rule.

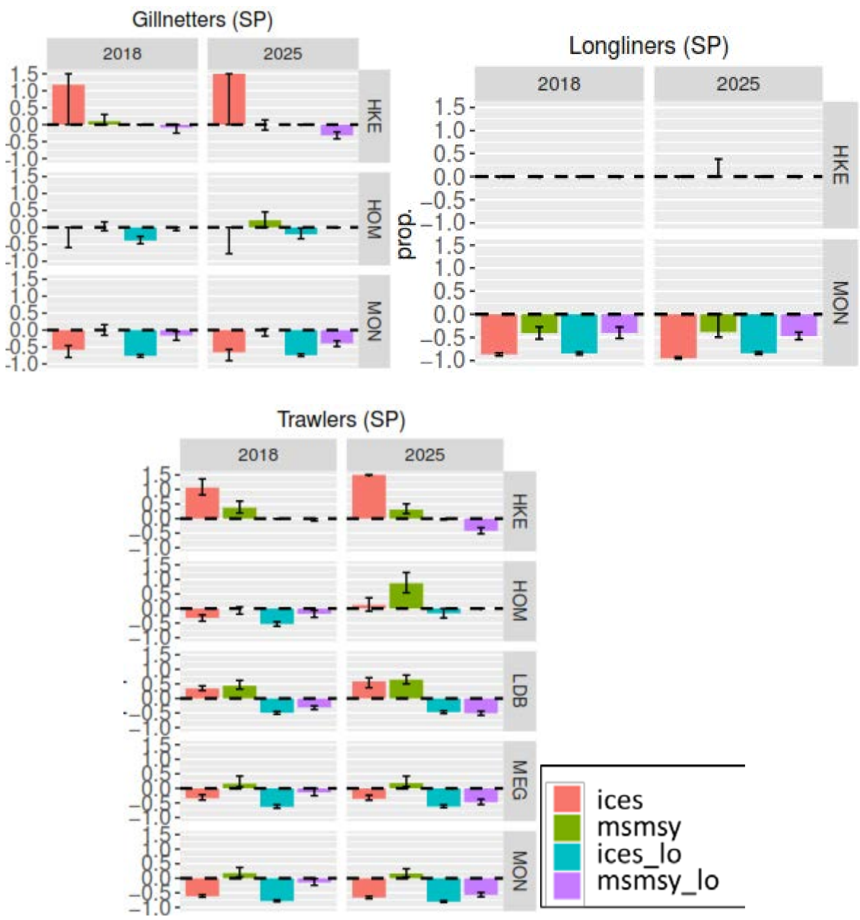

Figure 7 Quota uptake for each stock in years 2018 and 2025. Positive bars indicate that the TAC was overshot and negative bars that it was not exhausted. No bar indicates that the TAC was exhausted completely.

2.3.5.9 Conclusions

Multi-stock HCR:

- Takes advantage of the flexibility of the ranges to give the advice using the combination of fishing mortalities that maximizes the use of fishing opportunities.
- Results in better quota uptakes.
- Is able to bring the fishing mortality to the target or below it even without landing obligation.
  - Could be easily applied annually to produce 'consistent' TAC advice.
  - In contrast to FCube method, which is high data demanding; this method only uses the data from the assessment working groups.
- The performance of the HCR could be improved applying it at fleet level but the results could not be compatible with relative stability.
- The HCR should be tested under different scenarios of fleet dynamics, stock status and relative exploitation patterns in order to have a complete assessment of pros and cons of the approach.

2.3.5.10 References

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2.3.6 Advice to facilitate the implementation of the landing obligation

The landing obligation represents a major challenge for the countries in the allocation of quotas to the fleets. The success of the MAP is depending of this mechanism being well applied.

One the detailed output of FCube is the forecasted efforts and landings for each of the fleets included in the model. Presenting this information could help managers to identify potential problems and could form the basis for a discussion of the allocation of national quotas by fleets.

One type of potentially relevant information for the managers is the estimation of the effort corresponding to the quota for each of the stock caught by a given fleet. Representing this values on a radar plot (Figure 2.3.6.1) allows for a quick visualisation of the overall imbalance in the effort required, and help to identify potentially problematic stocks (e.g. choke species). On the example (Figure 2.3.6.1), there is little disparity in the effort for each stock for the fleet 1 (smaller effort is roughly at 80% of the largest effort), which suggests that mixed fisheries issues will be small for this fleet. In contrast, for fleet 2 the effort required to catch the eastern Channel plaice quota is nearly twice as high as the effort for the majority of the other stocks. In addition, effort corresponding to the haddock quota is markedly lower than for most of the other stocks. This indicates that this fleet will probably not be able to catch the totality of its eastern Channel plaice quota, and would need a higher haddock quota in order not to lose a substantial part of the fishing opportunities for the other stocks.

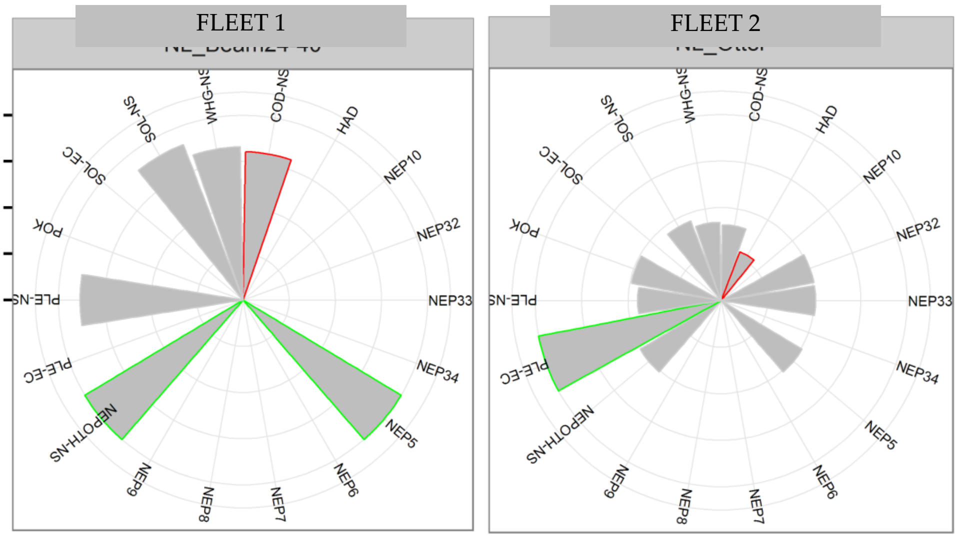

Figure 2.3.6.1 Example of the effort corresponding to the quotas for each stocks for two different fleets. Efforts for each stock are scaled for each fleet to the largest effort (depicted in green). The stock with the smallest effort is shown in red (based on the 2015 data).

2.4 Application of methodology to other ICES regions, fisheries and stocks

2.4.1 Analysis of métier coherence within the Celtic Sea

The purpose of analysis was twofold, firstly to identify if there are any natural métier aggregation levels apparent within the Celtic Sea. Secondly, to examine the appropriateness of running mixed fisheries simulations on the fleet categories of the previous cod long term management plan (TR1, TR2, TR3, BT1, BT2, GN1, LL1, GTR1) as used for mixed fisheries advice within the North Sea.

This analysis was a continuation of the analysis carried out at the 2015 MIXFISH methods group. Belgium, Ireland, France, and UK supplied data prior to the meeting, to perform a preliminary data screening. Landings dis-aggregated by métier (DCF level 6), year, vessel length categories (< 10 m, 10–24 m, 24–40 m, ≥ 40 m), and species for the last five years were made available. Species selected for analysis were determined at the 2015 MIXFISH-methods meeting and limited to those of particular interest to demersal mixed fisheries. Selected as national top 90% by landings or value excluding pelagic and shellfish (bar *Nephrops*), narrowed down to those under TAC restrictions within the area. All other species were submitted as "other" to allow examination of the full landings profile. Species alignment between nations was good. The one or two species of importance for one nation and not another were subsequently retained by each nation.

Analysis applied two multivariate methods to métier level landings data, firstly a principle component analysis followed by hierarchical clustering of the PCA results. This was carried out on two data sets, one with each year separately, the other aggregating over the five years. There was good agreement in identified clusters between the output of the year and the five year aggregated analyses. The individual year analysis identified the same overall species composition patterns of the five year aggregated analysis, although annual variation in specific proportions of individual species were observed. In a step wise process, a series of data refinements were made to improve the clarity of results. These included the removal métiers with very low landings volumes and not considered as representative (those with < 1% cumulative tonnage), removal of métiers where the "other" species category represented greater than 80% of the métier landings to allow focus on demersal and TAC based fisheries.

From initial analyses several interesting outcomes were observed:

- The low impact of vessel length categories, many of the length categories are found mixed together within identified clusters.
- And mixing of mesh size ranges, particularly the 70–99 and 100–119 mesh sizes, which would imply application of fleet segments separated based on mesh size is inappropriate.

As a result, further analyses were carried out excluding vessel length and mesh size ranges from métier categories essentially raise the classification level from métier to target species under the Data Collection Framework. These more refined analyses highlighted:

- Species as an important factor, with identification of different targets beyond the classification of DCF level 5, such as whitefish and flatfish target groupings.
- Gear is an important factor in species composition, with instances of clusters separating out twin rig demersal trawls, from the single rig equivalent, seine trawls, netting, and beam trawling.
- A spatial component was observed with separation of some areas, including 7.e and 7.f where landings compositions are quite different from other areas. These are areas with English and French fisheries and less participation from Irish vessels.
- There are a number of cases where English, French, and Irish métier landing profiles are similar enough to be grouped together. This is the case with the two closely related *Nephrops* métiers distinguished by the level of fish species present within the landings. While England and Ireland are in a

"cleaner" cluster, all three nations are present in a more mixed *Nephrops* cluster.

This work represents a more comprehensive analysis of métier species compositions within the Celtic Sea. However, as in 2015, data was not available from all nations fishing within the area, Spanish data was not submitted. A comprehensive detailed report of the results will be submitted for peer review and has been accepted for presentation at the 2017 Annual Science Conference.

One point highlighted, and still in need of a resolution, is the disparity between national métier classifications. Whereby, the landing composition of one national OTB-DEF is very similar to a different nations OTB-CRU. Nations need to check the species classifications and thresholds used to identify the DCF level 5 target species part of the métier are consistent with DCF definitions and between nations.

2.4.1 Optim scenario in the Celtic Sea

Development of an "optim" scenario was carried out, making use of the ICES defined MSY ranges to obtain optimised fishing opportunities in a mixed fisheries context, as has been done for the North Sea. The scenario was considered ready for application in the next MIXFISH-ADVICE meeting.

Inclusion of additional species into the analysis was also considered, given the status of the Sole 7.f and 7.g assessment, sole was considered for inclusion into the FCube analysis. This stock was included in a trial development in 2014 showing little interaction with the other demersal species incorporated. However, if over time the goal is to incorporate more species the fleet interactions may increase, for example the inclusion of place and anglerfish caught by both demersal otter trawls and beam trawls.

One of the most important species within the Celtic Sea is *Nephrops*, however largest obstacle to their inclusion is the analysis and publication of advice for these stocks occurs after both the WGMIXFISH-ADVICE and WGMIXFISH-METH working groups in November to account for the latest underwater TV surveys. Options for incorporating the most recent year of advice were discussed without satisfactory outcome. *Nephrops* will therefore continue to contain a lag in the analysis compared to other species.

2.4.2 Bay of Biscay

Annual mixed fishery advices are currently given for the North Sea and the Celtic Sea ecoregions and the Iberian Waters (ICES, 2016a). Such advices are required to meet the needs under the new Common Fisheries Policy to account for both technical and biological interactions between fisheries and stocks. In the past, the lack of métier-disaggregated catch and effort data has limited the development of mixed fisheries approaches in the Bay of Biscay but the use of the ICES InterCatch for the transmission and processing of biological and catch data to assessment working groups, and the joint WGBIE-WGMIXFISH data call, with métier-disaggregated catch and effort data, allow to make available the data needed to develop advisory methods to this ecoregion.

As a first step towards mixed fisheries advice for the Bay of Biscay (part of the Bay of Biscay and Iberian coast ecoregion), a preliminary application of the Fleet and Fishery Forecasting method "FCube" methodology (Ulrich *et al*, 2011) has been carried out. At this stage, the objective of the analysis was mainly to demonstrate the feasibility of the approach and only two stocks with analytical assessments (northern hake and Bay of

Biscay sole), considered as the most suitable initial candidates, were included. If the approach was to be used to provide advice, it would need to be developed and extended to further stocks for which important biological and technical interactions are taking place in the Bay of Biscay.

It is also important to highlight that various mixed fishery approaches are being developed for this area, using either the FLBEIA (Garcia *et al.*, 2012) or IAM (Merzereaud *et al.,* 2011) framework and that such approaches could be a complement to the FCube methodology. Future work should therefore include comparison of the different available approaches to identify the suitability of the methods for meeting different advisory objectives (i.e. short term advice, long-term management strategy evaluation etc.), as part of the general development of mixed fisheries advice.

2.4.2.1 Fisheries

The Bay of Biscay covers ICES divisions 8.a, 8.b, and 8.d. Fisheries are highly mixed, targeting a large range of species with different gears. Trawl fisheries (using otter, beam and pelagic trawl) take place for *Nephrops*, hake, anglerfishes, megrims, sole, sea bass as well as cephalopods (cuttlefish and squid). Net fisheries target sole, hake, pollack, seabass, anglerfishes as well as some crustacean species while a longline fishery targets hake. The fisheries are mainly carried out by French and Spanish vessels though some Belgian beam trawl vessels target sole.

Fishing operation (and the associated fleets) catching hake in ICES Division 3.a and subareas 4, 6 and 7 are also included in the current analysis to account for the whole fishing mortality on that species. Fishing operation in those areas are carried out mainly by vessels from Spain, France, Ireland and UK.

2.4.2.2 Data

2.4.2.2.1 Stock input data

The assessment data for the two stocks were taken from ICES WGBIE (2016b). Stock input data are not currently available as FLRStock objects. For sole, the assessment being carried out with XSA, the conversion of the data to FLRStock object was straightforward. For hake however, the assessment is carried out using a quarterly step stock dynamics implemented in Stock Synthesis (Methot and Wetzel, 2013). As a preliminary approach, we decided to combine the quarterly population dynamics parameters (numbers at age, fishing mortality at age) estimated by Stock Synthesis into yearly quantities so they could be directly included into FCube FLR. An alternative approach could be to develop a quarterly based version of FCube.

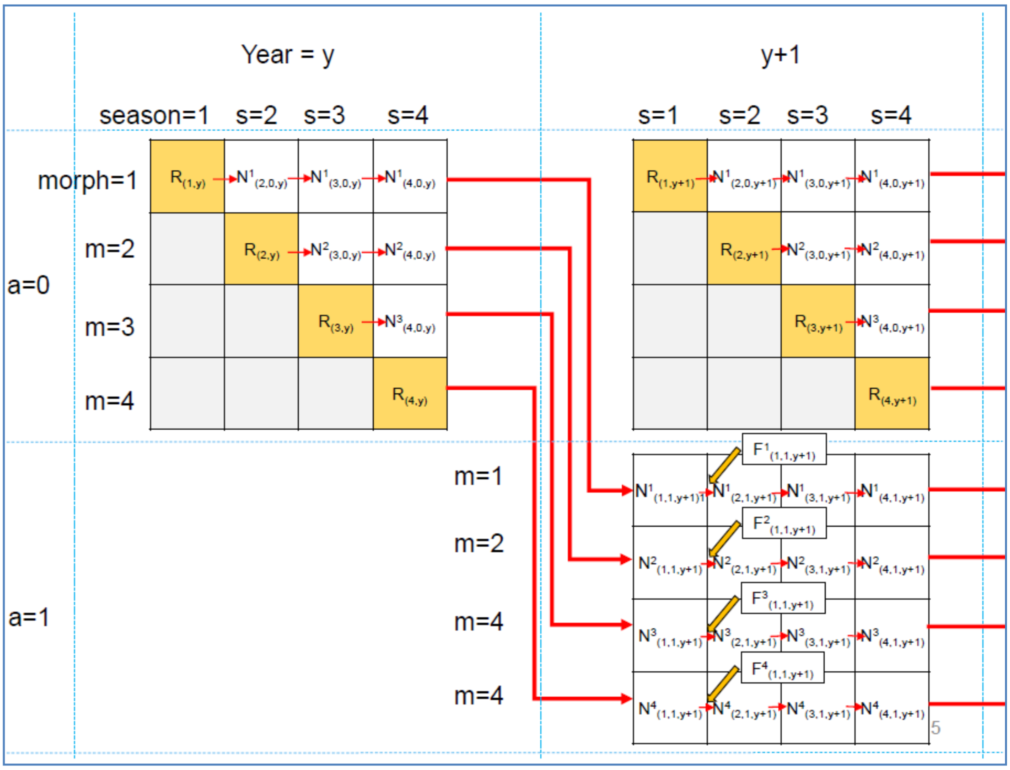

Figure 2.4.2.1 Simplified version of the quarterly stock dynamics as currently implemented in Stock Synthesis for hake. Each year is divided into 4 seasons (corresponding to 4 quarters) and the fate of 4 cohorts (or morphs) by age class are followed along the quarterly time steps. Each cohort recruits in a different quarter. For each year, age group and trimester, a morph dependent fishing mortality is applied to each morph $F^m_{s,a,y}$.

The numbers at age in the population (input to the FLR stock object) were calculated by summing up the number of survivors of each morph at the start of the year (quarter 1):

$$N_{a,y} = \sum_{m=1}^{nmorphs} N^m_{1,,a,y}$$

F at age by season were computed as a weighted sum of the morph dependent fishing mortalities:

$$F_{s,a,y} = \sum_{m=1}^{nmorphs} \left(N^m_{s,a,y} \Big/ \sum_{m=1}^{nmorphs} N^m_{s,a,y} \right) * F^m_{s,a,y}$$

They were then averaged over the 4 quarters to compute the annual F at age:

$$F_{a,y} = \frac{\sum_{s=1}^{nseas} F_{s,a,y}}{nseas}$$

2.4.2.2.2 Catch and effort input data

We used métier-based landing and effort files requested by the WGMIXFISH data call from 2015 and 2016. The procedure to define the fleets and métier in the model were similar to those applied in the North Sea or the Celtic Sea. In summary:

- Fleets were defined by aggregating landing and effort across country, gear group and vessel length (where applicable).
  - Any fleet landing < 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 landing files were matched to ensure consistency, métiers with effort and no landing were aggregated to the OTH fleet.
- Within a fleet, a métier was defined as a combination of gear, target species (e.g. demersal fish, DEF, or crustaceans, CRU) and areas (Bay of Biscay (BoB), Celtic Sea (CS) and West of Scotland and North Sea (North)).

The final data used contained 15 national fleets (plus the OTH fleet) from four countries (Table 2.4.2.1), covering landing and effort for the years 2014 and 2015. These fleets engage in one to eight different métiers each.

Table 2.4.2.1 Fleets used in the Bay of Biscay analysis and corresponding total landings by year and stock.

	2014		2015	
fleet	HKE	SOL	HKE	SOL
ES_Gillnet_all	2094		1965	
ES_Longline_all	20265		21284	
ES_Trawl_24<40m	3537		4793	
FR_Gillnet_10<24m	4994	2606	1892	2549
FR_Gillnet_24<40m	15095	0	11295	0
FR_Longline_10<24m	897		5482	4
FR_Longline_24<40m	6973		11679	
FR_Trawl_>=40m	1987		1955	
FR_Trawl_10<24m	6662	1171	7195	903
FR_Trawl_24<40m	2644	4	2656	2
IE_Trawl_10<24m	1006		1061	
IE_Trawl_24<40m	825		960	
OTH_OTH	8449	419	11221	11
UK_Longline_all	5367		2555	
UK_Trawl_10<24m	830		1048	

The balance of landings of the stocks across gear categories is shown in Figure 2.4.2.1. As more than 70% of hake landings are caught in area outside the Bay of Biscay, technical interaction with the Bay of Biscay sole stock is limited to few métiers.

All the analysis was performed on landings. While this is not an issue for sole for which discards are limited, this is not the case for hake for which discards are important for some fleets.

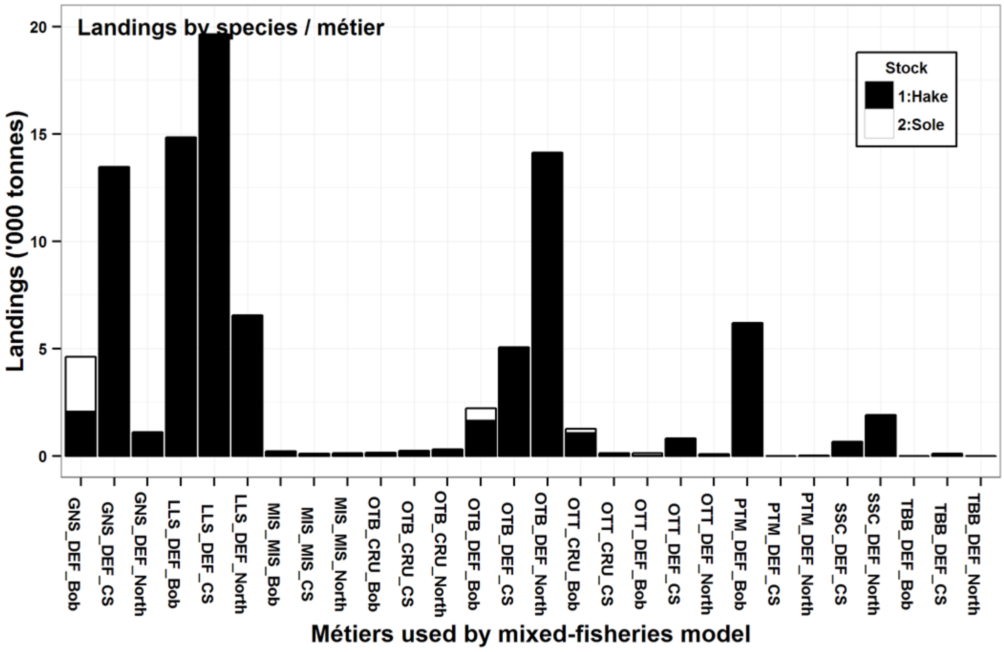

Figure 2.4.2.1 Landing distribution of species by métier.

As a cross check of the data, the total landings across all fleets was compared to the values estimated from the single species stock assessments (Table 2.4.2.2). The landings coverage is high for hake but not very good for sole. This discrepancy needs to be investigated further.

Table 2.4.2.2 Proportion of the stocks total landings (from WGBIE) covered by the MIXFISH fleets. A ratio > 1 means that the catch information in MIXFISH is higher than the information used by WGBIE.

Year	stock	WG.landings	ratio.l	MIX.landings	difference
2014	HKE	85044	1.00	84703	-342
2015	HKE	89702	1.01	90678	976
2014	SOL	3599	1.17	4200	601
2015	SOL	3328	1.04	3469	141

2.4.2.3 Results

Results are only presented here to illustrate the feasibility of mixed-fishery short-term forecasts for the Bay of Biscay.

2.4.2.3.1 Baseline runs.

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

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

No issues were encountered in replicating the single stock advice. The results from these baseline runs are compared with the results from the corresponding ICES runs in Table 2.4.2.3. The replicated forecast for both stocks were almost identical to the single stocks advices, even in the hake case which is using a different software and stock dynamic model for short term projections.

Table 2.4.2.3. Comparison between baseline run and ICES advice for both stock.

		HKE	SOL
2016	Landings Baseline	98207	3734
	Landings ICES	98842	3734
	% difference	-1%	0%
2017	Landings Baseline	115749	3077
	Landings ICES	111865	3107
	% difference	3%	-0.97%

2.4.2.3.2 Mixed fisheries runs.

Mixed fishery forecasts were performed based on the scenarios used in the North Sea, the Celtic Sea and the Iberian Waters advice, these scenarios are:

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.

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.

hake: All fleets set their effort corresponding to that required to land their quota share of the hake, regardless of other catches.

sole: All fleets set their effort corresponding to that required to land their quota share of the sole, regardless of other catches.

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

Figure 2.4.2.2 presents the level of effort required by each fleet to catch their quota share of the single stock TAC advice. This highlights the much lower effort required to fulfil the sole quota for 2017 than the one required for hake.

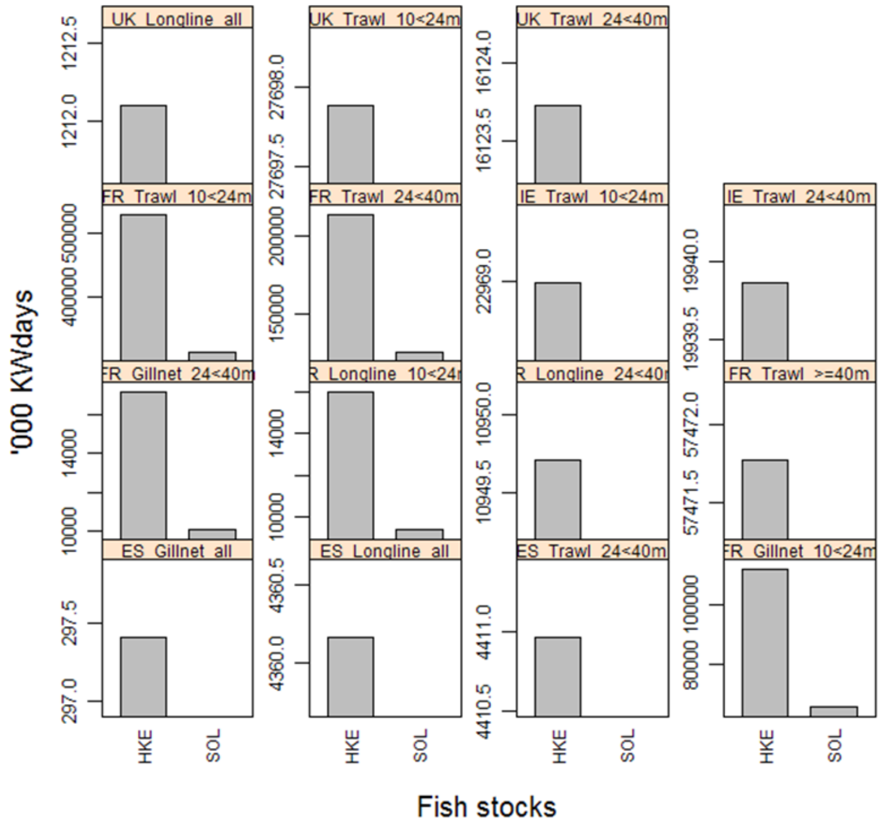

Figure 2.4.2.2 FCube estimates of effort by fleet corresponding to the individual "quota share" by stock in 2017.

The TAC year landings under the mixed fisheries scenarios are summarized in Figure 2.4.2.3, with the forecast fishing effort by fleet in Figure 2.4.2.4.

The « hake » and « max » are driven by the level of single stock hake fishing effort. They result in over-quota landings for sole.

The « sol » scenario is driven by the level of single stock sole fishing effort. For the fleets landing sole, the fishing effort is reduced to the level of fishing effort required to fulfil the sole quota for 2017 while for the other fleets, the fishing effort is kept constant. For the « min » scenario, the fleets landing sole, adjust their fishing effort to the level of fishing effort required to fulfil the sole quota for 2017 while the other fleets adjust their fishing effort to the level of fishing effort required to fulfil the hake quota for 2017. Both scenarios lead to underutilization of catching opportunity for hake

The sq_E scenario results in overshoots for while there is an undershoot of the hake TAC.

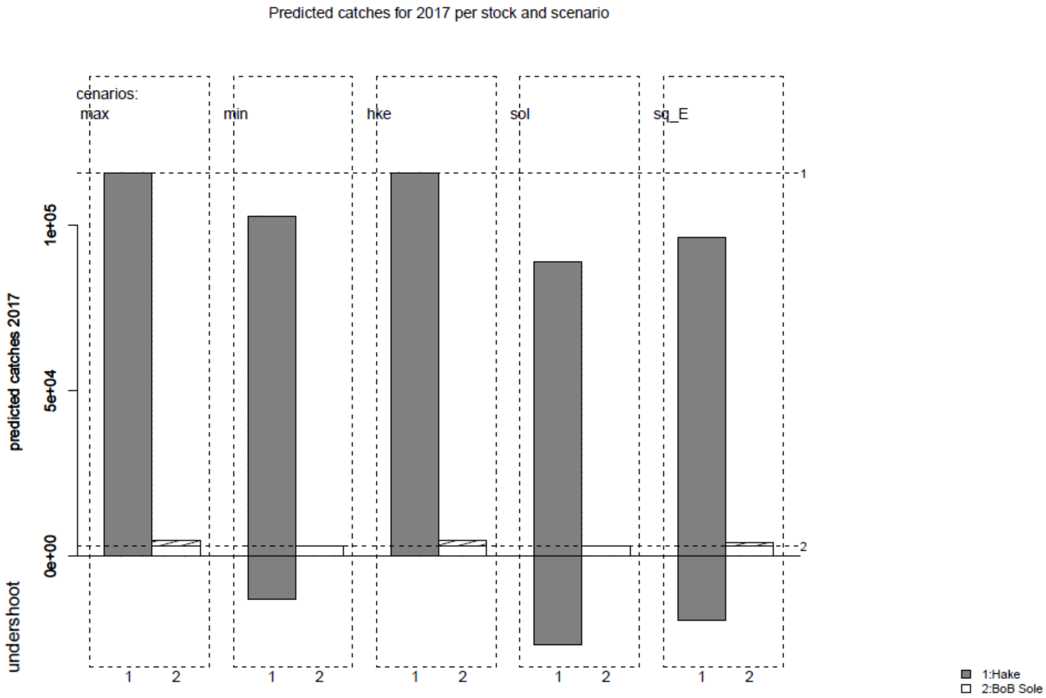

Figure 2.4.2.3 TAC year results (2017). FCube estimates of potential landings by stock after applying the status quo effort scenario to all stocks in the intermediate year followed by the FCube scenarios. Horizontal lines correspond to the TAC set by the single-stock advice. Bars below the value of zero show the scale of undershoot (compared to the single species TAC) in cases where landings are predicted to be lower when applying the scenario.

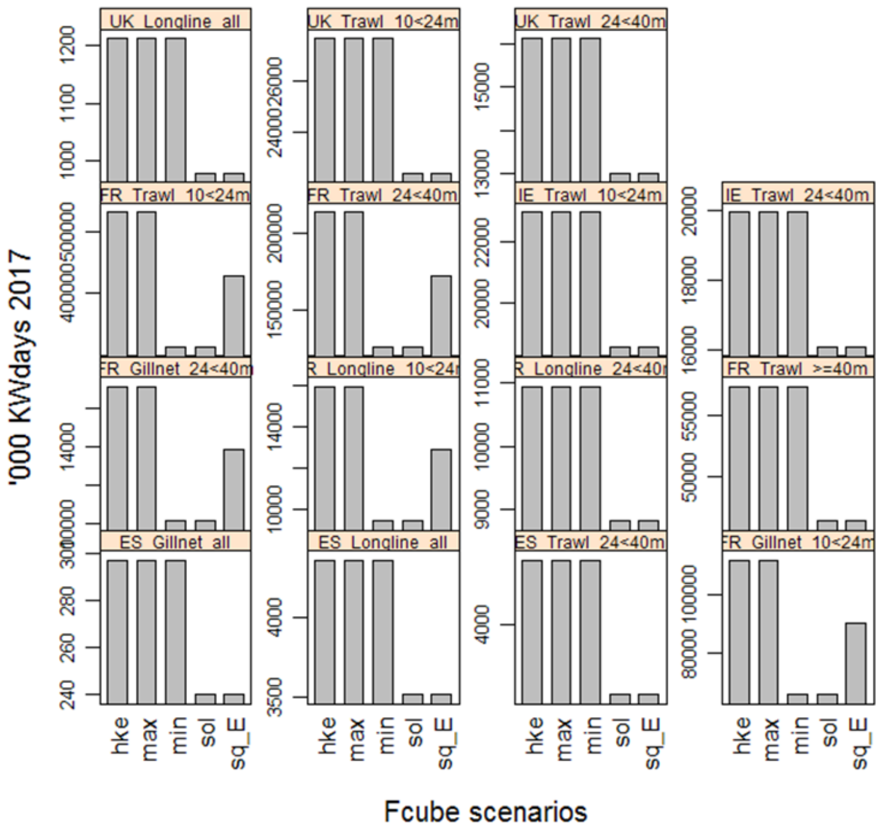

Figure 2.4.2.4 FCube estimates of effort by fleet and by scenario for 2017.

2.4.2.4 Conclusions

This analysis shows that it is currently possible to generate Bay of Biscay mixed fisheries considerations based on current available data and the FCube method. However, one limitation of the present implementation is the somewhat “limited” level of interaction between fleets and métier for the two stocks considered as a large part of the fishing activity on hake is taking place outside the Bay of Biscay. Further work is needed to take into account other important species that are caught simultaneously with hake and sole. This could include at very short term megrim and *nephrops* for which analytical assessment are (or will soon be) available.

One of the objectives of the analysis was also to test the possibility to parameterize FCube with a stock assessed with a model (Stock Synthesis) based on a different population dynamics configuration (quarterly time steps and cohorts). The results obtained show that for short term forecast, results obtained by both models are very similar.

Finally, discards have not yet been included in the analysis for hake. This still needs to be done as the hake discarding rates can be important for several of the fleets operating in the fishery.

3 Terms of Reference B

3.1 Develop and agree on a work flow to ease the process of MIXFISH-ADVICE for the next years (from data submission by the countries to data exchange with ICES (Stock assessment data, InterCatch data))

3.1.1 Gitlab

The WGMIXFISH decided to move all model code and relevant data to a repository on GitLab (https://gitlab.com/WGMIXFISH/WGMIXFISH) in order to facilitate exchange among members and maintain a common version control framework ("git"). GitLab (rather than GitHub) was chosen for the reason that we were able to host a private repository free of charge, but the repository can be easily moved to another hosting site if preferred.

Maintaining a common repository will allow all members to continually update changes to code while ensuring that all maintain current versions. Additional specifications (e.g. R version, methodology) will also be maintained in a "README.md" file – preferably using markdown notation, which can be easily converted into other reports if needed. The git framework also allows for the use of repository "branches" for testing of new methodologies, prior to being merged with the "master" repository. Finally, we plan to utilize the ability to "tag" versions of the repository at important milestones in time; for example, the final version of the model repository used for a given report in time (e.g. tag: "WGMIXFISH_Advice_2016"). This creates a copy of the repository at that point in time, which will ensure transparency and reproducibility in the future while allowing the working group to continually progress with a current version.

Given that many of the model scripts are based on the statistical programming language R, we have also included an R project file ("WGMIXFISH.Rproj"), which can be used to initialize R within RStudio. This has the advantage of setting the top-level working directory during initialization depending on the user's local repository on their computer. All other script paths are defined relative to this working directory, allowing for ease of reproducibility without detailed file path changes at setup.

Some general functions needed by all groups are to be maintains in a top level subfolder, ensuring consistent methodologies amongst specific case studies; e.g., main functions of FCube. An additional folder has been created to maintain R package versions, ensuring consistency among users. An example of the repository structure at present is as follows:

- /functions - some general functions that are available to all WGs (e.g. FLFcube_FLCore_R31.R)
- /packages - zipped versions of packages used for the present version (e.g. from FLR)
- /North_Sea - subfolder for North Sea case study
    - /optim - optimizer routine
    - /programs - 3 main steps of FCube (Repr. stock advice, Conditioning of fleets, Projection)
- /Celtic_Sea - subfolder for Celtic Sea case study

In an effort to track developments and changes to the base codes used by each of the regions, the group decided to store R codes on GitLab, "an application to code, test, and deploy code together. It provides Git repository management with fine grained access controls, code reviews, issue tracking, activity feeds, wikis, and continuous integration." Essentially a version control tool. During the meeting, a WGMIXFISH GitLab account was set up to be populated with the final (alpha) regional R codes used during the WGMIXFISH-Advice group in May.

All R codes relating to the final (alpha) FCube assessment of the Celtic Sea mixed fishery carried out in May 2016 were cleaned, removing unused or irrelevant code, and transferred to the WGMIXFISH GitLab account for use in the next WGMIXFISH-ADVICE group. Particular attention was paid to the initial R codes aggregating and mapping metiers to match between the mixed fisheries data call and InterCatch submissions.

3.1.2 Look up table for next data call

Part of the data processing when creating the FLFleet object involves assigning InterCatch data (discard rates and age composition) to the metiers in the catch and effort data submitted through the WGMIXFISH data call. In some cases, there may be a greater number of metiers present in the submitted catch and effort files compared to InterCatch and vice versa. To resolve this, several metiers from one of the datasets are grouped together and matched to one metier from the other dataset. For example, the Scottish metiers for longlines, gillnets and small mesh size otter trawlers submitted in the catch and effort data are matched to the MIS_MIS_0_0_0_HC in the InterCatch file. The catch for these metiers is small enough that the catch can be aggregated and reported to InterCatch under the miscellaneous metier. Conversely, the French submission to InterCatch has a number of trammel net metiers which are grouped and matched to the single trammel net metier in the data submitted to WGMIXFISH.

However, these metiers groupings may not be applicable for more recent submissions and new metiers may have been added since these metier groupings were originally defined. Furthermore, there have been several recent benchmarks for North Sea stocks and so historical data in InterCatch will have been updated with the metier definitions. As a result, a table listing the catch/effort metiers and the InterCatch metiers they are matched with was produced to evaluate the sensibility of the metier allocations. Once checked, this table can then be used as a lookup table to correctly match the metiers and their groupings and facilitate writing the next data call asking for a resubmission of data to WGMIXFISH.

4 Develop and/or compile a stock annex of the mixed fisheries methodologies

This table was updated in October 2017

The table below provides an overview of the WGMIXFISH Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes".

STOCK ID	STOCK NAME	LAST UPDATED	LINK
mix.ns	North Sea Mixed Fisheries Annex	May 2017	mix.ns_SA
mix.bbi	Iberian Water Mixed Fisheries Annex	May 2015	mix.bbi_SA
mix.cs	Celtic Sea Mixed Fisheries Annex	May 2015	mix.cs_SA

5 Additional issues considered

5.1 Fisheries overview–Technical interactions

Many fishing gears catch more than one species, so 'technical interactions' between stocks occur when multiple stocks are captured in the same gear during fishing operations. Because these interactions may vary in time and space (e.g. interactions can differ between day and night, occur at different times of the year, and among different areas), it would be ideal if these could be identified at very small temporal and spatial scales. However, as most fisheries data are aggregated based on species, gear, mesh size range, ICES square, and calendar quarter, subtle interactions may be missed.

ICES has evaluated technical interactions between species captured together in demersal fisheries by examining their co-occurrence in the landings at the scale of gear/mesh size range/ICES square/calendar quarter (hereafter referred to as 'strata'). The percentage of landings of species A, where species B is also landed and constitutes more than 5% of the total landings in that stratum, has been computed for each pair of species. Cases in which species B accounts for less than 5% of the total landings in a stratum were ignored.

To illustrate the extent of the technical interactions between pairs of species, a qualitative scale was applied to each interaction (Figure 14). In this figure, horizontal bars represent the share of each species A that was caught in fisheries where the B species accounted for at least 5% of the total landing of the fisheries. A high proportion of the catches of lemon sole was for example taken in fisheries where plaice landings where at least 5% of the total landings. The amounts of lemon sole caught in fisheries where cod, haddock, hake or saithe accounted for at least 5% of the total landings were medium. The amount of lemon sole caught in fisheries where lemon sole constituted 5% or more of the total landings were low, indicating that there is no (or very limited) target lemon sole fishery.

The vertical bars illustrates the degree of mixing. Fisheries where plaice (species B) constitute 5% or more of the total landings account for a high share (red cells) of the total landings of dab, lemon sole, plaice, sole, turbot, flounder, brill, haddock, and which, and a medium share (orange cells) of the landings of whiting, hake and *Nephrops*. The lemon sole column shows that the landings of lemon sole in fisheries where the species constituted 5% or more of the total landing were low and the relative landings of other species in this fisheries were also low. The columns can be used to identify the main fisheries (target fisheries) and the degree of mixing in these fisheries.

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

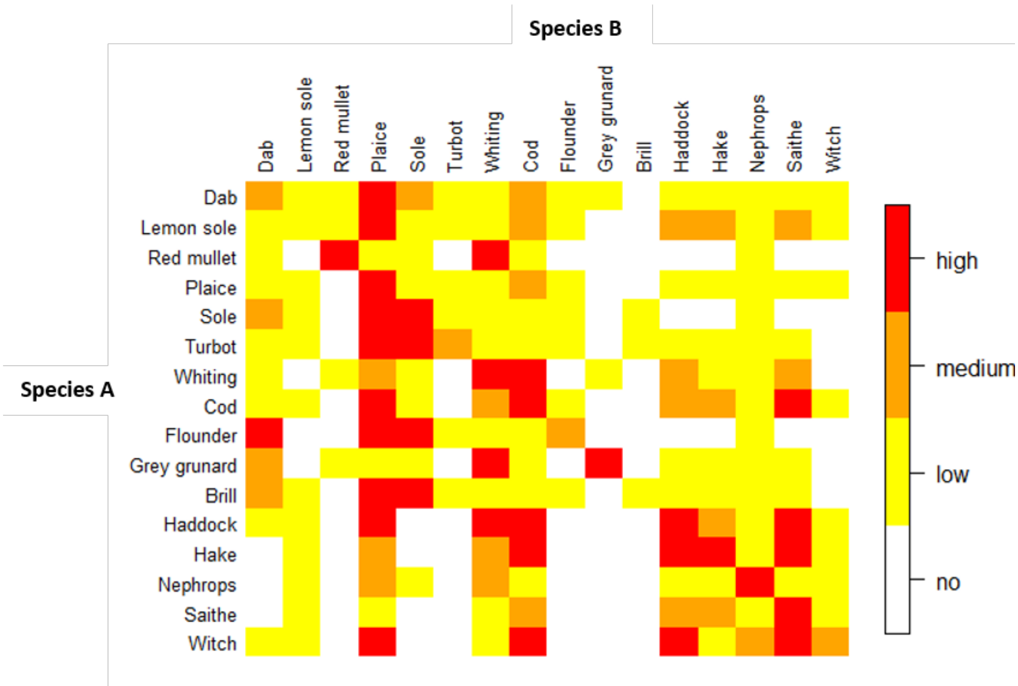

Figure 14 Technical interactions amongst North Sea demersal stocks. Horizontal lines of the figure represent the target species of the fishery for which the interaction with species in each column was assessed. Red cells indicate that the species are frequently caught together. Orange cells indicate medium interactions and yellow cells indicate weak interactions. For example, haddock sometimes occur in catches in the whiting fishery (a 'medium' interaction) but whiting often occur in catches in the haddock fishery (a 'high' interaction).

6 Conclusions and Recommendations

The working group met 10–14 October in Charlottenlund and progressed five key issues:

The 'Optim' scenario was finalized and applied to the North Sea and Celtic Sea areas. This scenario searches for the minimum sum of differences between potential catches by stock under the "min" and the "max" scenarios within the F_{MSY} ranges. This scenario aim at reducing the inconsistencies between single stock advices by taking advantages of the F_{MSY} ranges. However as defined now it implies that some stock are fished under F_{MSY} and other above F_{MSY}. This scenario can now be applied during the MIXFISH-ADVICE group as an alternative scenario.

The workflow to produce the input data to FCube model and the script to run the model and produce tables and figures from the results were cleaned and put under a Gitlab project. These procedures ensure that the last version of the code and data used to produce advice is stored and saved. All the process can then be reproduced in case some changes appear in the input data or single stock advices.

Figures to represent technical interactions has been developed. This figure will be proposed for incorporation in the fishery overview under development.

The coherence of the métiers within the Celtic Sea was explorered. This work represents a more comprehensive analysis of métier species compositions within the Celtic Sea. However, as in 2015, data was not available from all nations fishing within the area, Spanish data was not submitted. A comprehensive detailed report of the results will be submitted for peer review and has been accepted for presentation at the 2017 Annual Science Conference. One point highlighted, and still in need of a resolution, is the disparity between national métier classifications. Whereby, the landing composition of one national OTB-DEF is very similar to a different nations OTB-CRU. Nations need to check the species classifications and thresholds used to identify the DCF level 5 target species part of the métier are consistent with DCF definitions and between nations.

The mixed fisheries interaction in the context of the MAPs was clearly described and several solutions were described to overcome choke species effects.

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Annex 2: Proposed ToR for 2017 WGMIXFISH Meetings

WGMIXFISH-ADVICE – Working Group on Mixed Fisheries Advice

2016/#/ACOM## The **Working Group on Mixed Fisheries Advice** (WGMIXFISH-ADVICE), chaired by Youen Vermard, UK, will meet at ICES Headquarters, 22–26 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 XXXX 2017, and the management measures in place for 2018;

b) Carry out mixed demersal fisheries projections for the Celtic Sea taking into account the single species advice for cod, haddock, whiting and sole 7fg that is produced by WGCSE in XXXX 2017, and the management measures in place for 2018; 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 XXXX 2017, and the management measures in place for 2018; and further develop advice for the region. In particular, how advice for Horse mackerel produced by WGHANSA meeting in XXXX 2015 can be incorporated into the mixed fishery forecasts;

d) Produce a draft mixed-fisheries section for the ICES advisory report 2017 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 ## ### 2017 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.

WGMIXFISH-METH – Working Group on Mixed Fisheries Advice Methodology

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

WGMIXFISH will summarise the ongoing knowledge around mixed-fisheries issues, and will provide some evaluation of the state of implementation of the landings obligation

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

Supporting Information

Priority:	The work is essential for ICES to progress in the development of its capacity to provide advice on multi-species 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. However, in practice all recent advice in this area has resulted from the work and analyses done by sub-groups of STECF rather than 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 in 2010 to 2012.
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.