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Scientific, Technical and Economic Committee for Fisheries (STECF)

Management plans part 2 - developing area based management plans (STECF-12-14)

Edited by John Simmonds & Ernesto Jardim

This report was reviewed by the STECF during its' 40th plenary meeting held from 9 to 13 July 2012 in Copenhagen, Denmark

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Joint Research Centre

Institute for the Protection and Security of the Citizen

Contact information

STECF secretariat

Address: TP 051, 21027 Ispra (VA), Italy

E-mail: stecf-secretariat@jrc.ec.europa.eu

Tel.: 0039 0332 789343

Fax: 0039 0332 789658

https://stecf.jrc.ec.europa.eu/home

http://ipsc.jrc.ec.europa.eu/

http://www.jrc.ec.europa.eu/

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Management plans part 2 - developing area based management plans (STECF-12-14)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN COPENHAGEN, DENMARK, 9-13 JULY 2012

Background

Multi-stock plans

According to the CFP reform proposal current single-species management shall be replaced with multi-stock management plans where species and/or fisheries are linked with each other either through the food web (multi-species) or through technical interactions in the associated fishery (mixed fisheries).

The general policy objective would be to provide long-term sustainable environmental, economic and social conditions and contribute to the availability of food supplies. Based on the general objective, multi-stock plans would have the following objectives:

- Adapting fishing mortality to ensure management of all stocks concerned according to MSY by 2015.
- Implementation of an ecosystem –based approach to fisheries and facilitating the implementation of the MSFD in particular with regards to descriptors and targets related directly or indirectly to fisheries (descriptor 3, 4 and 6). In particular, the plans should deliver low risk of depletion of individual stocks, low impact on non-target species and low impact on sensitive habitats.
- Elimination of discards and minimisation of bycatches

Given the management areas used by ICES, the RAC areas, and the stock areas used in existing management plans for the NE Atlantic, it is foreseen to develop area based management plans as follows:

Baltic Sea

Celtic Sea

Irish Sea

West of Scotland

Western Channel

North Sea

Bay of Biscay

IberianAtlanticCoast

Eastern Channel would either be combined with the Western Channel or the North Sea

Kattegat would either be combined with the Skagerrak or the North Sea

As regards stocks crossing multiple areas (e.g. Hake and Horse Mackerel) two options have preliminary be identified:

a) area based plans will include management measures for stocks crossing through areas

b) single stock plans will be established or maintained for these stocks

In order to ensure future multi-stock plans will correspond in a sensible way to existing relations between stocks and fisheries and their preparation timing will correspond to availability of respective scientific advice, STECF is requested to provide advice for the preparation and planning for multi-stock plans for the North Sea, West of Scotland, Celtic Sea, Irish Sea, Western Channel according to the TORs given below.

Bay of Biscay and Iberian Atlantic Coast will be addressed at a subsequent EWG meeting according to the same TORs.

Request to the STECF

STECF is requested to review the reports of the STECF Expert Working Group (EWG-12-07), evaluate the findings and make any appropriate comments and recommendations.

In addition STECF was requested to look at the following additional related TOR:

Bio-economic models will be needed that would enable to tackle the complexity inherent to multi-species fisheries and mixed fisheries. Models are expected to deliver a range of management options (output) under various management scenarios (input). Where possible, the social dimension (employment) of the fisheries should be accounted for, so that all three dimensions of sustainable development are correctly assessed.

STECF are requested to examine and give advice on the state of play in terms of existing and under development bio-economic modelling tools for mixed fisheries / mixed species management, and when completed/tested models will be available for use in assessing options for management "ex ante", in particular in light of any possible interdependence between this work and the work referred to in paragraph 2. STECF are requested to review the features of the various models, their intended outputs and provide a critical assessment of their respective pros and cons.

In light of the preceding analysis, STECF are requested to advise whether a single bio-economic modelling tool might suffice to cater for all areas ("one size fits all"), whether it should be possible to develop a common basis that could be then adapted with relative ease to each region or area, or if a specific model is needed for each area.

STECF observations and conclusions

STECF has reviewed the reports and makes the following observations and conclusions for the headings below. The additional ToR has been addressed and the response is presented at the end of the section.

Area boundaries options and modeling aspects

he working group considered the appropriateness of area boundaries for fisheries management purposes considering two main criteria; whether stocks would cross boundaries and whether fisheries would cross boundaries

Pros and cons for the following boundaries were identified:

- boundary between North Sea and Channel; boundary between Celtic Sea and Channel
- boundaries between North Sea, West of Scotland and CelticSeas
- boundary between West of Scotland and North Sea
- boundary between West of Scotland and CelticSeas
- boundary between the proposed Northern Shelf area of IV and Southern North Sea
- boundary between North Sea and Baltic Sea
- northern boundary between Irish Sea and West of Scotland
- southern boundary between Irish Sea and CelticSea
- boundary between CelticSea and Bay of Biscay

It was concluded that it may be preferable to join Eastern Channel with the North Sea and to join the Western Channel with CelticSeas. It is considered preferable to join both Kattegat and Skagerrak with the North Sea management area largely because of the important *Nephrops* fisheries that extend over both subdivisions.

The Northern boundary of the Irish Sea is considered to be appropriately located, a minor modification is proposed for the southern boundary to deal with catches that are taken within the current area and reallocated to CelticSea.

Fishing activities are strongly economically linked between VIa north and IVa, and between VIa south and CelticSeas suggesting there may be potential benefits in splitting the West of Scotland area and joining the two parts accordingly. Such an approach would create a very large ‘greater North Sea’ with diverse fleets and there is potential to split this along a largely hydrographic boundary reducing the scale of the area and reducing fleet diversity within areas. The proposed areas are illustrated below:

Generally each area will require at least 6 person months to put together single species simulation models for assessed stocks and a small number of important non-assessed stocks. The resource requirements for CelticSeas are expected to be greater. Development of mixed

fisheries advice for the North Seacould progress relatively quickly. The West of Scotland is the next area where progress can be made on mixed fisheries once the North Sea work is complete. Substantial work is required to give mixed fish advice for all other areas. In all cases, progress is conditional upon the allocation of resources.

Currently only small scale ad hoc economic analysis can be provided based on the existing tools. It is anticipated it will be between 2 to 3 years to provide more comprehensive area-based economic advice as this is conditional on developing ways to link the biological and economic data. Furthermore, the progress is provisional on the fact that participating scientists have the relevant expertise, time and resources necessary. Much of the current development is linked to the timetable of ongoing EU projects. These results are developed further in the additional ToR concerning bio-economic modeling (see Table 5.5.1) below.

STECF endorses the evaluation of the pros and cons of area boundaries presented by the working group. In many ways the proposed structure of area boundaries provides a more coherent structure than the current areas. However, the radical changes suggested could potentially create problems with relative stability, and differ also from the current RAC areas. Moreover, although it removes some problem of some straddling stocks it may replace them with others.

STECF recommendations

There are no specific STECF recommendations

Additional Request – Examination and advice on Bio-economic models

In addition to the evaluation of EWG 12-07 which contained aspects of economic modeling an additional related TOR was added after the EWG met and STECF was requested to consider the report and the additional TOR given above. For completeness the STECF response to this request is include here.

STECF response to additional ToR

STECF would like to reiterate its recommendation from STECF PLEN-11-03 that data collected under different EU programs and DCF have to be compatible if bio-economic modeling should be further developed and improved. In particular, there is an urgent need to harmonize gear and area descriptors between economic and biological data calls, as well as to improve the consistency of transversal data such as effort and landings by fleet and métier across these data calls. At present, economic data are only available for aggregated groups of vessels assigned to a single majority activity (to preserve confidentiality) without detailed information on their actual fishing activities, while biological data are collected at the scale of fishing activities (or métiers) without insights of how individuals select different combinations of activities, making the two data sets largely irreconcilable as they are currently requested under Data Calls. In practice, it might be possible to link the two through

allocation to fleets and métiers of logbooks data crossed with fleet register. STECF emphasizes that the DCF needs to explicitly improve this link.

Table 1 below gives the state of play of the recently developed bio-economic models and of those under development. The list may be incomplete since it is based on the knowledge of experts in attendance at this STECF plenary meeting.

Table 1 The state of play of the recently developed bio-economic models and of those under development. The list may be incomplete since it is based on the knowledge of experts in attendance at STECF plenary meeting July 2012.

Model	**Description**	**Status**	**Development Framework**	**Steps required including ICES work**	**Applied in areas**	**Pros**	**Cons**
ATLANTIS	Three-dimensional ecosystem model, linked polygons that represent major geographical features. Information is added on local oceanography, chemistry and biology such as currents, nutrients, plankton, invertebrates and fish. The model is then set in motion, simulating ecological processes such as consumption and production, waste production, migration, predation, habitat dependency, and mortality.	Developed but not tested in EU waters	Several EU Framework programs are developing ATLANTIS models for EU waters. Expected to be finished within the next 3 years (EU VECTORS project).		North Sea, Eastern Channel	-Ecosystem model with all natural feedbacks included. -Follows the MSE approach -Spatially explicit	-Data and time heavy -Not integrated with biological assessment advice.
ECOPATH-FISHRENT	Ecopath creates a static mass-balanced snapshot of the resources in an ecosystem and their interactions, represented by trophically linked biomass 'pools'. The biomass pools consist of a single species, or species groups representing	Under development	'MYFISH' project. This is expected to be finished within the next 3 years		Southern North Sea	-Aims at combining ecological and ecosystem interactions while considering all main economic	-Data and time heavy -Not integrated with biological assessment advice.

	ecological guilds. This model combines ECOPATH with FISHRENT (see below)					features.	
F-CUBE	F-CUBE (Ulrich et al. 2011) estimates the potential future levels of effort by fleet corresponding to the fishing opportunities (TACs by stock and effort allocations by fleet) available to that fleet, based on effort distribution across its métiers, and the catchability of each of these métiers. This level of effort is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.	Developed and used mainly on the biological side, although it can be adapted to economic modules	Model has been finished and used for ICES advice. Development is ongoing for new management objectives and MSE approach.		North Sea regularly (included in ICES), Mediterranean and Western Waters in 2009. Will be applied in the area West of Scotland.	-Directly operational for advice. -Consistent with other FLR objects and ICES advice. -Flexible to address different issues without too much effort.	-Ad-hoc code development. -Not spatially explicit - Limited inclusion of uncertainty
FISHRENT	FISHRENT (Salz et al. 2011) estimates resource rents under different conditions and management regimes. It integrates simulation and optimisation, integrates output- and input-driven approaches, so that it can be consistently applied to different situations in the EU, particularly the Atlantic and the Mediterranean/Black Sea areas. To this end, it accommodates multi-	Developed* and tested	Original model developed under the EU project 'Remuneration of spawning stock biomass'. Further development done in 'VECTORS' project.	Estimation of several parameters. (catch functions,..)	All areas	-Successfully tested in all different geographical areas. -Developed in order to be run with existing DCF data which all MS possess.	-Not integrated with biological assessment advice. -Does not follow MSE approach.

	species/ multi-fleet fisheries. The recent developments integrate spatial and seasonal dimensions of fisheries and age structured population dynamics.						
FLR/FLBEIA	FLBEIA is a bio-economic model embedded in FLR (Kell et al. 2007) It is a toolbox for bio-economic impact assessments with MSE. It's multi-fleet, multi-stock, and seasonal. and merges the main ideas of Fishrent and Fcube.	Under development	Model is being developed as a collaboration between a group of scientists, promoted by JRC and coordinated by AZTI. Developed and tested by the end of 2012.	Estimation of several parameters. (catch functions,..)	Bay of Biscay, Gulf of Cádiz	-Coupled with the biological assessments. -Designed as a tool box to allow for flexibility for handling different models.	-Data and time heavy -Not user-friendly
IAM	IAM is a bio-economic model used for the impact assessment for sole in the Bay of Biscay. It was developed in the framework of the Bio-economic partnership working group project funded by the French Ministry of Agriculture and Fisheries.	Developed* and tested	Model was used for impact assessment for sole in the Bay of Biscay		Bay of Biscay	-has delivered bio-economic outcomes for a range of Impact Assessments (STECF 10-10 and 11-04)	- No application to other areas is known to STECF
ISIS-FISH	ISIS-fish (Mahevas and Pelletier, 2004) is a generic and spatially explicit simulation tool for evaluating the impact of	Developed and tested.	Model has been developed and applied in several research projects.	Estimation of several paramethers.	Bay of Biscay, North Western Mediterranean	-Spatially explicit	-Data and time heavy

	management measures on fisheries dynamics. Both management measures and behaviour of fishermen in reaction to these measures may be interactively designed through a Script language						
NWWRAC - DST	Stochastic Decision Support Tool (DST) to assess stock and economic impacts of options for changes in gear and fleet selectivity to support the NWWRAC initiative to develop a mixed fisheries management plan for the Celtic Sea. Deterministic gear selectivity model already available	Under development	Initiative proposed by NWWRAC to support CS MP. Requires resource allocation (18 month development time)		NWWRAC Celtic Sea Intend to be applicable for all areas.	-User-friendly. -Aiming at RACs for their decision making process of mixed fisheries.	-Without resource allocation development will be hindered.
FLR - SMS	Fully integrated and spatially explicit bioeconomic model (Bastardie et al., 2010) with MSE approach, coupled with a SMS multispecies operating model	Developed and tested. Used by STECF (2012) for developing multispecies management plans in the Baltic	Is being extended into an Individual-Based modeling for the Baltic		Eastern and Western Baltic	-Can address a great range of biological and economic questions at several scales.	-Data and time heavy. -Cannot be easily transferred to other areas.
Ecopath with	Standard modeling tool	Developed and	Is being currently	Development	North Sea, other	-Fleet structure	-Data and time

Ecosim (EwE)	including all trophic levels in an ecosystem, with a time-based simulation frame. Applied in many areas worldwide.	tested for the North Sea (Mackinson et al., 2008)	further developed in GAP2 in collaboration with North Sea RAC.	is linked to ICES WGSAM key runs.	areas worldwide	based on DCF, relatively easy to update. -Can explicitly take account of changes in both productivity and fishing drivers. -- Includes economic information from AER	heavy -Not fully integrated with biological assessment advice. - Not fully validated yet
AHF	Created to simulate the economic behavioural response of fishing fleets to the economic outcome in previous years of the fishery with response to the entry exit or invest/disinvest in the fishery changing fleet capacity.	Developed	EFIMA project		Atlantic waters	-Can be run using DCF data -Can assess effort regulations	-Results are extremely sensitive to the calibration of the model
BIRDMOD	A simulation model to predict effects of different management policies from a biological, economic and social perspective and consists of 4 modules; a biological, an economic, management and a state variation module.	Developed	FISBOAT project		Mediterranean	-Advice in relation to changes in selectivity, taxes and subsidies	-specifically designed for Mediterranean fisheries

BEMMFISH	Projects biological and economic variables into the future to test different Mediterranean fisheries management and policies.	Developed	BEMMFISH project		Mediterranean	-Assess changes in taxation	-Limited number of fleets and species
COBAS	An option comparison model in which the effects of a particular policy are compared to the effect of the current management system.	Developed	IiFSW Project		English Channel, Celtic Sea and Western approaches.	-Is an option comparison model	-No biological model
EcoCoRP	A simulation model to assess the economic impacts of effort reductions imposed by the North Sea Cod recovery plan of the North Sea fishing fleet segments.	Developed	EcoCoRP tender		North Sea	-Incorporates short-terms impacts and multi-species interactions.	-Very case studyspecific.
ECONMULT	A simulation model for the management of the Barents Sea fisheries using a multi-species and multi-fleet approach in which the user can define the dimensions.	Developed	Norwegian Research Council project		Barents Sea fisheries	-Fleets can be modeled at various aggregations	-It does not include any biological model
EMMFID	An optimization and simulation model to clarify the economic consequences of fishery management regulations and industry activities.	Developed	Project EMMFID		Danish fishery sector	-Designed for national management plans	
MEFISTO	Bioeconomic Simulation model in which under	Developed	Project		Mediterranean	-Input measures	-Not output

	alternative management scenarios fisheries management characteristic of the Mediterranean are emulated		BEMMFISH			implemented. -Very detailed	orientated
SRRMCF	Model to operationalise a strategic management plan for the commercial Swedish fishery with the aim of providing viable solutions for the structural problems in the fishing industry.	Developed	Swedish Board of Fisheries project.		Sweden	-Designed for strategic management plan	-Only applied in Sweden

**main parts have been developed and tested.Some parts still under development.*

The same model can be applied in different geographical areas once it has been re-parameterised. This has for example already been the case for a number of these, such as FISHRENT, FLR, Fcube, ISIS-Fish, etc, which have been used to evaluate different fisheries of the Atlantic and Mediterranean areas. In that sense STECF is of the opinion that a single model could be adapted to any area, provided that the required data to reparameterise stocks and fleet are available. Nevertheless, the main differences between the models are the answers that they can provide as well as the level of detail in which the ecological, economic and biological dimensions are considered and modeled. In that sense, STECF considers that the diversity of models provides a value in terms of the management options for which they can provide an assessment. Furthermore it can be anticipated that new research questions and/or changes in the availability of data, will increase the necessity of using different models, the development of new and/ or the adaptation of old ones.

STECF also considers the necessity of testing the different models before they are applied to any Impact Assessment. Furthermore STECF considers that different models should be compared with the same set of data in order to check the robustness of the modeling.

There are currently a number of integrated EU projects aiming at bringing further together ecology and economy (e.g. MYFISH, VECTORS, ECOKNOWS, SOCIOEC, GAP2, BENTHIS), and it is clear that most model development is taking place within this frame. STECF considers that regular linkages and communication across EU DGs about monitoring and use of outcomes of these research projects would ensure the best cost-benefit return of these.

REPORT TO THE STECF

EXPERT WORKING GROUP ON
Management plans part 2 - developing area based management plans.
(EWG-12-07)

Edinburgh, Scotland, 18-22 June 2012

1 EXECUTIVE SUMMARY

The STECF Expert Working Group (EWG-12-07) on Management plans pt2 developing area based management plans met in Edinburgh, Scotland from 18 to 22 of June 2012. The EWG considered aspects of the revision of cod plans which are contained in a separate report STECF-12-13. The EWG also considered the organisation of area based management plans, the boundaries between areas, the resources, timetables and biological and economic modelling needs which are reported here.

A review of areas has concluded that it may be preferable to join the Eastern Channel with the North Sea and join the Western Channel with Celtic Seas. It is considered preferable to join both Kattegat and Skagerrak with the North Sea largely because of the important *Nephrops* fisheries. The Northern boundary of the Irish Sea is considered to be appropriately located, a minor modification is proposed for the southern boundary to deal with catches that are taken within the current area and reallocated to Celtic Sea. Fishing activities are strongly linked economically between VIa north and IVa, and VIa south and Celtic Seas suggesting there may be potential benefits in splitting the West of Scotland area and joining the two parts accordingly. Such an approach would create a very large 'greater North Sea' with diverse fleets and there is potential to split this along a largely hydrographic boundary reducing the scale of the area and reducing fleet diversity within areas.

For each area modelling possibilities are outlined and indicative resource implications identified for different options. Generally each area will require at least 6 man months to put together single species models for assessed stocks and a small number of important non-assessed stocks. The resource requirements for Celtic Seas are expected to be greater. Development of mixed fisheries advice for the North Sea can progress relatively quickly if resources are allocated. The West of Scotland is the next area where progress can made once the North Sea work is complete. Substantial work is required to give mixed fish advice for all other areas.

Currently only small scale *adhoc* economic analysis can be provided based on the existing tools. It is anticipated it will be between 2 to 3 years to provide more comprehensive area based economic advice and this is conditional on developing ways to link the biological and economic data

2 CONCLUSIONS OF THE EXPERT WORKING GROUP

A review of areas has concluded that it may be preferable to join Eastern Channel with the North Sea and join the Western Channel with Celtic Seas. It is considered preferable to join both Kattegat and Skagerrak with the North Sea largely because of the important *Nephrops* fisheries. The Northern boundary of the Irish Sea is considered to be appropriately located, a minor modification is proposed for the southern boundary to deal with catches that are taken within the current area and reallocated to Celtic Sea. Fishing activities are strongly economically linked between VIa north and IVa, and VIa south and Celtic Seas suggesting there may be potential

benefits in splitting the West of Scotland area and joining the two parts accordingly. Such an approach would create a very large 'greater North Sea' with diverse fleets and there is potential to split this along a largely hydrographic boundary reducing the scale of the area and reducing fleet diversity within areas. For each area modelling possibilities are outlined and indicative resource implications identified for different options. Generally each area will require at least 6 man months to put together single species models for assessed stocks and a small number of important non-assessed stocks. The resource requirements for Celtic Seas are expected to be greater. Development of mixed fisheries advice for the North Sea can progress relatively quickly if resources are allocated. The West of Scotland is the next area where progress can made once the North Sea work is complete. Substantial work is required to give mixed fish advice for all other areas.

Currently only small scale *adhoc* economic analysis can be provided based on the existing tools. It is anticipated it will be between 2 to 3 years to provide more comprehensive area based economic advice and this is conditional on developing ways to link the biological and economic data

3 RECOMMENDATIONS OF THE EXPERT WORKING GROUP

The EWG was not able to advise on the southern boundary to the Celtic Sea which forms the Northern Boundary of the Bay of Biscay. This should be included in the ToR for the next meeting.

4 INTRODUCTION AND TERMS OF REFERENCE

4.1 Introduction

According to the CFP reform proposal current single-species management shall be replaced with multi-stock management plans where species and/or fisheries are linked with each other either through the food web (multi-species) or through technical interactions in the associated fishery (mixed fisheries).

The general policy objective would be to provide long-term sustainable environmental, economic and social conditions and contribute to the availability of food supplies. Based on the general objective, multi-stock plans would have the following objectives:

- Adapting fishing mortality to ensure management of all stocks concerned according to MSY by 2015.
- Implementation of an ecosystem–based approach to fisheries and facilitating the implementation of the MSFD in particular with regards to descriptors and targets related directly or indirectly to fisheries (descriptor 3, 4 and 6). In particular, the plans should deliver low risk of depletion of individual stocks, low impact on non-target species and low impact on sensitive habitats.
- Elimination of discards and minimisation of bycatches

Given the management areas used by ICES, the RAC areas, and the stock areas used in existing management plans for the NE Atlantic, it is foreseen to develop area based management plans as follows: Baltic Sea, Celtic Sea, Irish Sea, West of Scotland, Western Channel, North Sea. Bay of Biscay, Iberian Atlantic Coast.

Eastern Channel would either be combined with the Western Channel or the North Sea.

Kattegat would either be combined with the Skagerrak or the North Sea

As regards stocks crossing multiple areas (e.g. Hake and Horse Mackerel) two options have initially been identified:

a) area based plans will include management measures for stocks crossing through areas

b) single stock plans will be established or maintained for these stocks

In order to ensure that future multi-stock plans will correspond in a sensible way to existing relations between stocks and fisheries and their preparation timing will correspond to availability of respective scientific advice, STECF is requested to provide advice for the preparation and planning for multi-stock plans for the North Sea, West of Scotland, Celtic Sea, Irish Sea, Western Channel according to the TORs as follows.

Bay of Biscay and Iberian Atlantic Coast will be addressed at a subsequent EWG meeting according to the same TORs.

4.2 Terms of Reference for EWG-12-07

Given the management areas used by ICES, the RAC areas, and the stock areas used in existing management plans for the NE Atlantic, it is foreseen to develop area based management plans as follows: Celtic Sea, Irish Sea, West of Scotland, Western Channel, North Sea

1. Identify cases where stocks cross multiple geographical areas or fishing activities or are strongly economically linked between areas.

Advise on potential implementation problems of the area based approach specified above. For each case discuss how this might be addressed taking account of the two identified options on how to deal with stocks crossing multiple areas.

For the Eastern Channel discuss pros and cons of combining it either with the Western Channel in one plan or including it into a plan for the North Sea.

2. For each area outline the steps required, and give an indicative timeline for the development of the scientific basis including tools for the evaluation of different options for a multi-stock plan as regards each of the objectives specified above. This should take account of any work planned by ICES on this topic. Specify any further research or preparatory analysis needed.

3. For each area outline which kinds of economic analysis can be provided based on tools existing or under preparation and advice on which additional tools would be needed

5 GENERAL CONSIDERATIONS

The objectives of fisheries management under the CFP is the sustainability of biological economic and social elements of fisheries. This management is often aimed first at sustainable fish stocks, currently with a policy of exploitation at Fmsy, and then at socio-economic objectives. These objectives are to be obtained primarily through the management of fisheries, through a variety of measures aimed at controlling the outtake of the fisheries through TACs and in some cases input through effort and or capacity. Thus in the first instance it is fleets, vessels or operators that are to be controlled, the influence on stocks a secondary process. As management is carried out through this mechanism it is important to consider management through a combination of the distribution of stocks, the fleets or vessels that fish on one or more of these stocks, the behaviour of these vessels and how this may change over time.

The discussion below is based on some general considerations of currently defined areas, then each area boundary is considered in detail with respect to the stocks and the fisheries contained within or straddling two or more areas. Where conclusions appear clear both in separation of stocks and fisheries, the EWG draws such conclusions, in other cases the pros and cons of boundary placement are discussed.

5.1 CURRENT AREA DEFINITIONS

This EWG considered the area definitions SGMOS 10-03 which looked at areas defined by ICES, MSFD and RACs.

The STECF SGMOS 10-03 examined Celtic Sea and the North Sea ecosystems as case studies and considered they represented a good compromise in term of size. SGMOS 10-03 considered these ecosystems are compatible with stocks-based and fleet based analyses and with modelling approaches as well. Smaller ecosystems can also be considered in more detailed research programs and for local management but a larger scale seems to be more appropriate for providing scientific advice to European political bodies. SGMOS 10-03 considered that much larger areas than the Celtic and North Seas would be characterized by a high heterogeneity in terms of both ecological processes and fleet dynamics.

Compatibility with existing limits data collection and analysis limits are necessarily important. FAO and ICES divisions and subdivisions (Figure 5.1) are the basis for all the catch and effort statistics and this system of areas is used to define stocks limits or to specify a most of fisheries regulations. They can be considered a basis for the development of plans under the Common Fishery Policy.

Marine eco-regions have also been defined in the context of the Marine Strategy Framework Directive (MSFD) (Figure 5.2). Nevertheless, SGMOS 10-03 considered these limits would be difficult to use directly because they are designed for national jurisdictions assessed on a national basis and thus, MSFD do not match with ICES subdivisions limits and fisheries regulation.

ICES and RAC divisions are illustrated in Fig 5.1 taken from SGMOS 10-03 and the list of identified areas from SGMOS 10-03 is given in Table 5.1

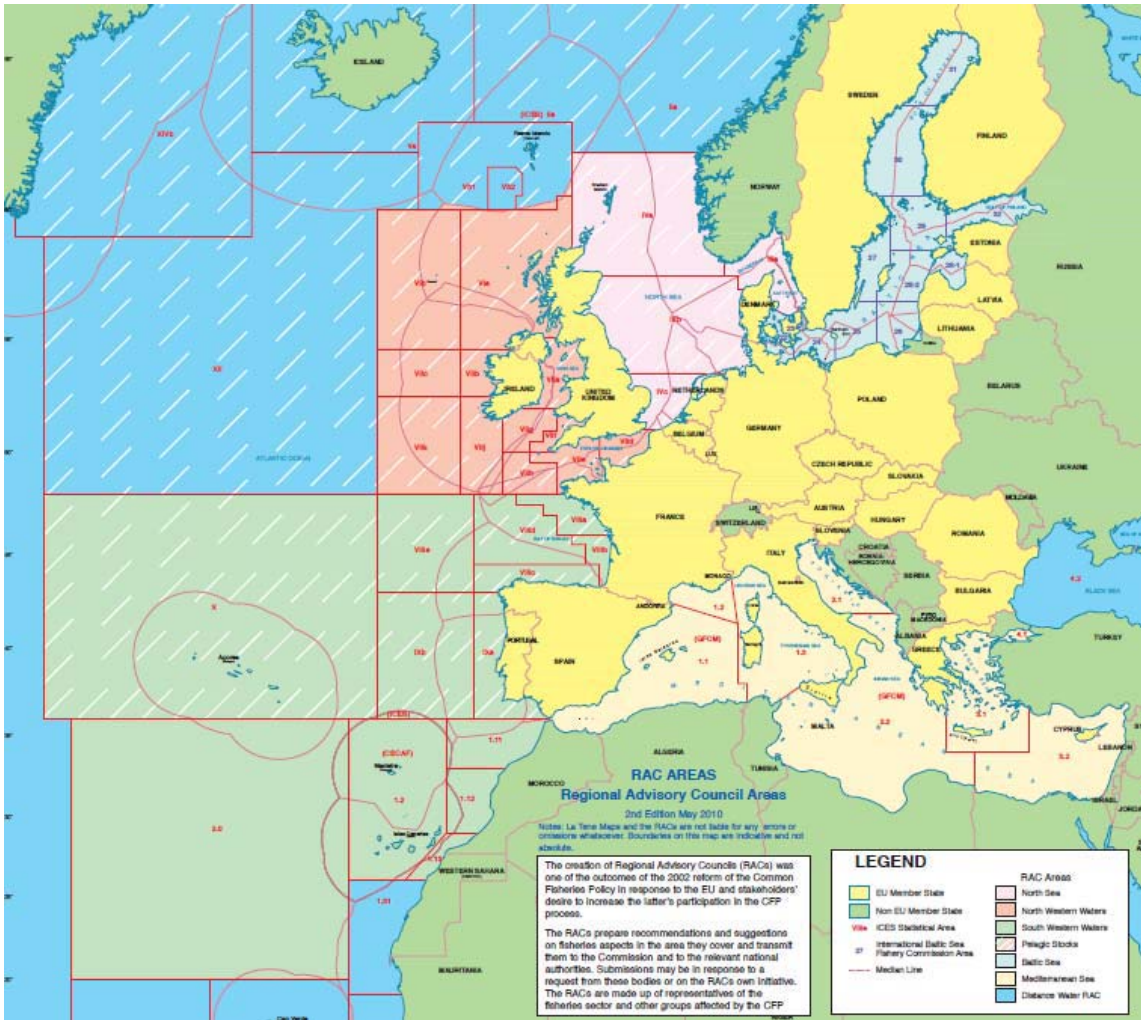

Figure 5.1 ICES areas, divisions and subdivisions (equivalent to FAO areas),

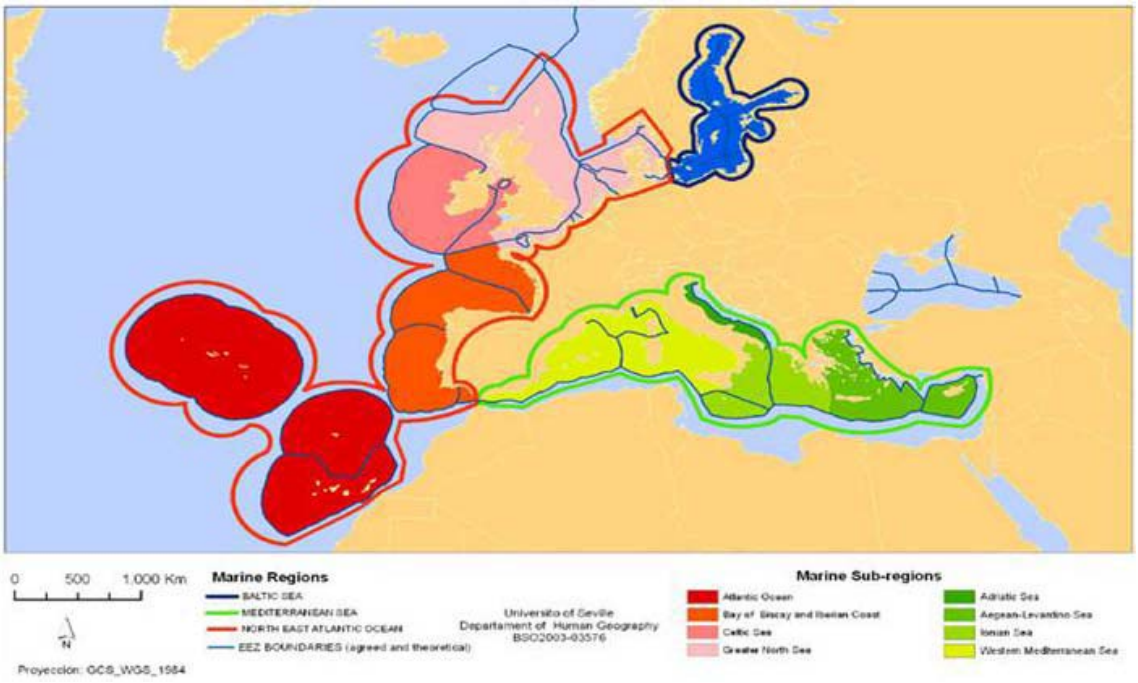

Figure 5.2 National and MSFD areas (taken from SGMOS 10-03).

Table 5.1. Reference list of European marine ecosystems suggested by the SGMOS working group on EAFM

	Ecosystem	FAO subdivisions	Depending on the RAC:	MSFD Marine region close
1	Baltic sea	ICES IIIb, 22-32	Baltic sea	Baltic sea
2	North sea	ICES IVa-c, IIIa, VIId	North sea (except VIId)	North sea
3	West Scotland/Ireland	ICES VIa-b, VIIb-c	North western waters	North sea / Celtic sea
4	Irish sea	ICES VIIa	North western waters	Celtic sea
5	Celtic sea	ICES VIIe-k	North western waters	Celtic sea
6	Bay of Biscay	ICES VIIIabd	South western waters	Bay of Biscay and Iberian coast
7	Iberian coast	ICES VIIIc, IXa	South western waters	Bay of Biscay and Iberian coast
8	Acores	ICES X	South western waters	Atlantic ocean
9	Canarias, Madeira	CECAF 1.2	South western waters	Atlantic ocean
10	Western Mediterranean Sea	GFCM 1.1, 1.2 & 1.3 (GSA 1-12)	Mediterranean Sea	Western Mediterranean Sea
11	Adriatic Sea	GFCM 2.1 (GSA 17-18)	Mediterranean Sea	Adriatic Sea
12	Central Mediterranean Sea	GFCM 2.2 (GSA 13-16, 19-21)	Mediterranean Sea	Ionian sea
13	Eastern Mediterranean Sea	GFCM 3.1, 3.2 & 4.1 (GSA 22-28)	Mediterranean Sea	Aegean-Levantin sea
14	Black sea	GFCM 4.2 (GSA 29)	- none -	

5.2 FISHERIES AND THE DISTRIBUTION OF LANDINGS

Data from the STECF database on EU landings by ICES rectangle for demersal species are plotted by species in Figures 5.1 to 5.10, each plot contains all landings for that species irrespective of stock, there are additional plots by gear for cod (Figure 5.3). These plots show how there is often spatial separation between fisheries for different species or species groups. The discussions on the fisheries given below refer to these Figures. Figure 5.11 shows the location fisheries in Celtic Sea and around Ireland based on broad area classifications derived from the main target species using a clustering analysis of logbook data linked with VMS (Gerritsen et al, (in press)).

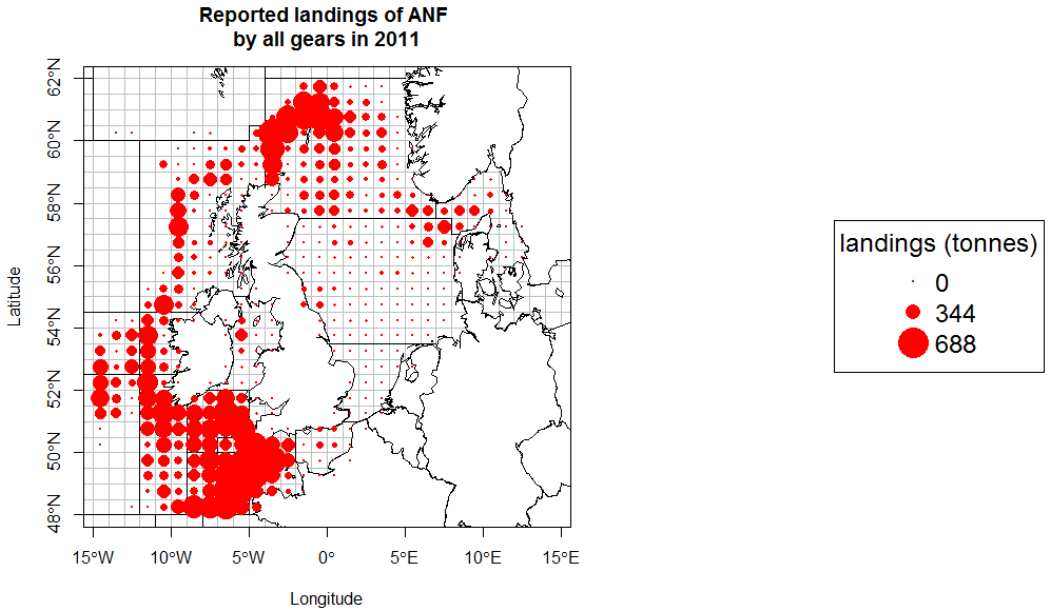

Figure 5. 1 EU landing distribution for anglerfish in 2011

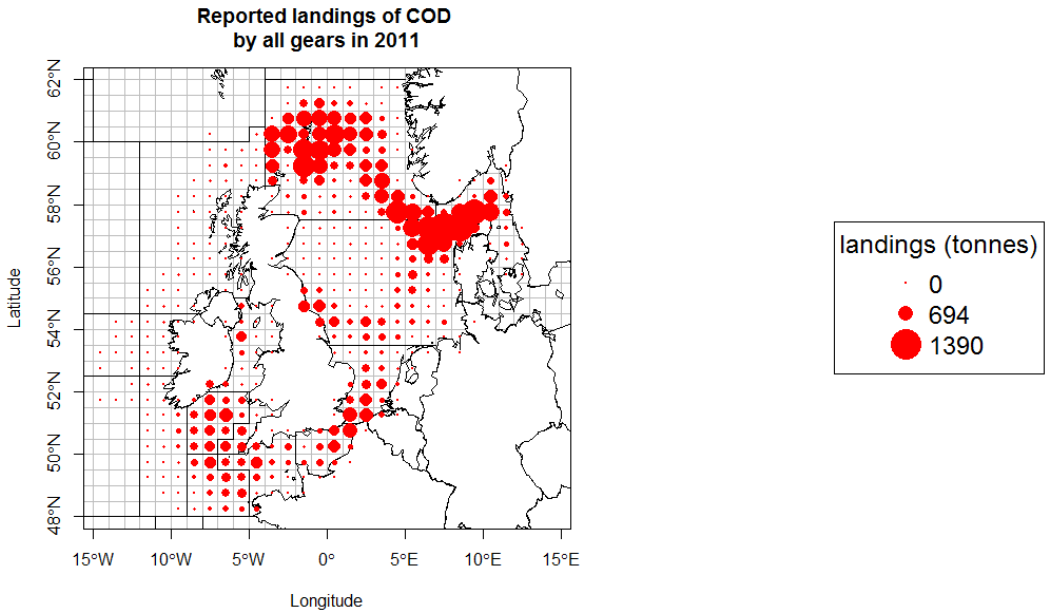

Figure 5.2 EU landing distribution for cod in 2011

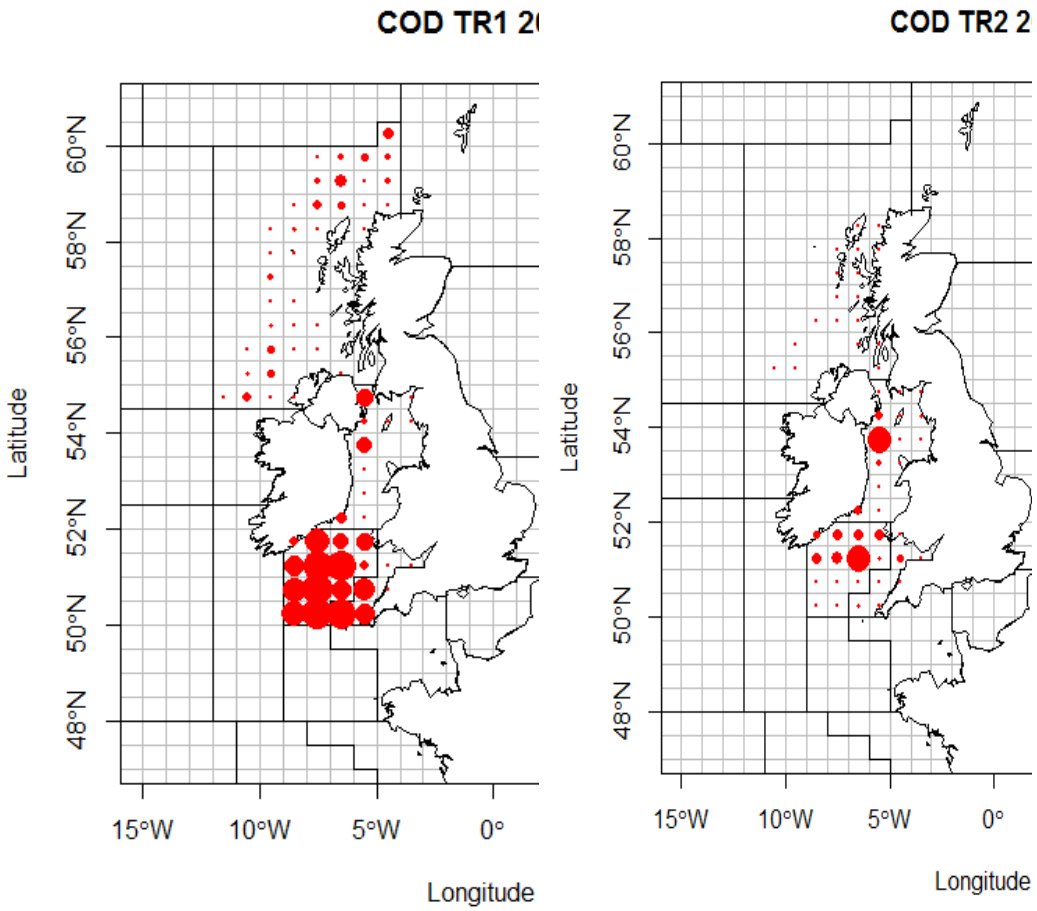

Figure 5.3 EU landing distribution for cod in 2011 by the TR1 (predominantly whitefish directed) and TR2 (predominantly *Nephrops* directed) in the Irish Sea and neighbouring management areas.

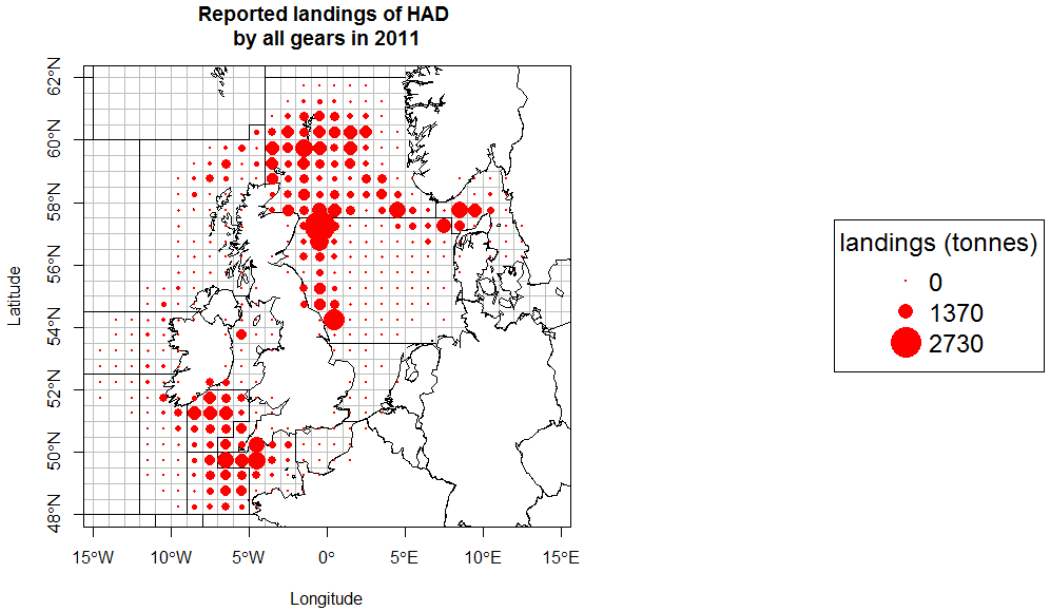

Figure 5.4EU landing distribution for haddock in 2011

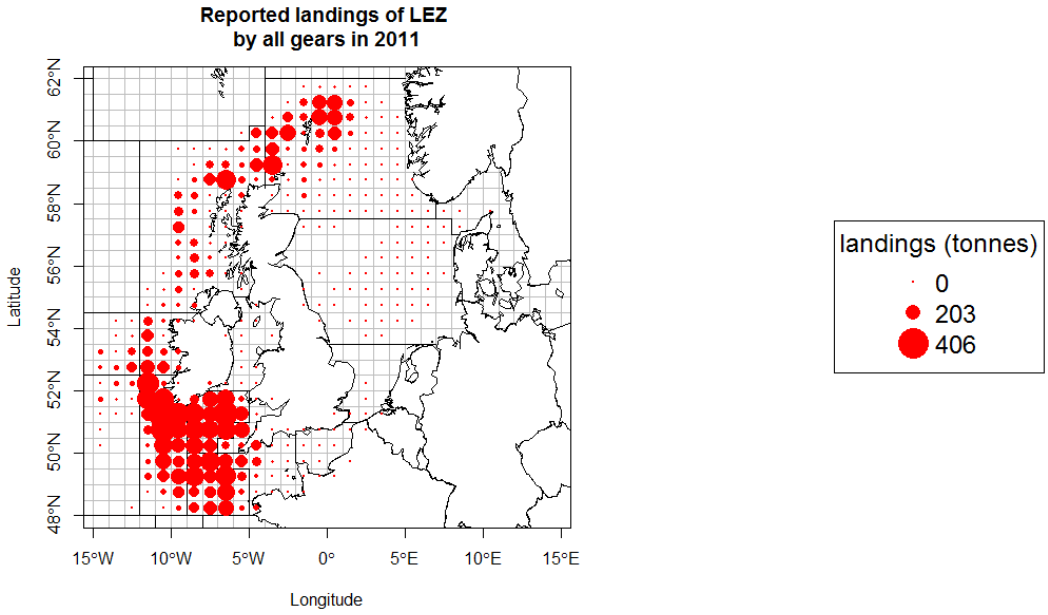

Figure 5.5 EU landing distribution for megrim in 2011

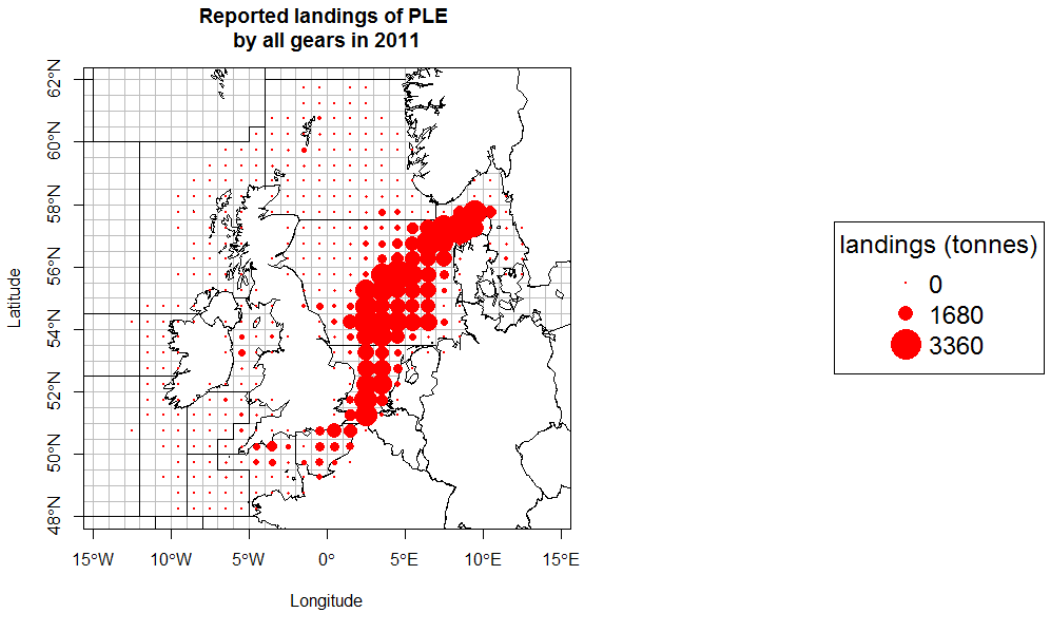

Figure 5.6 EU landing distribution for plaice in 2011

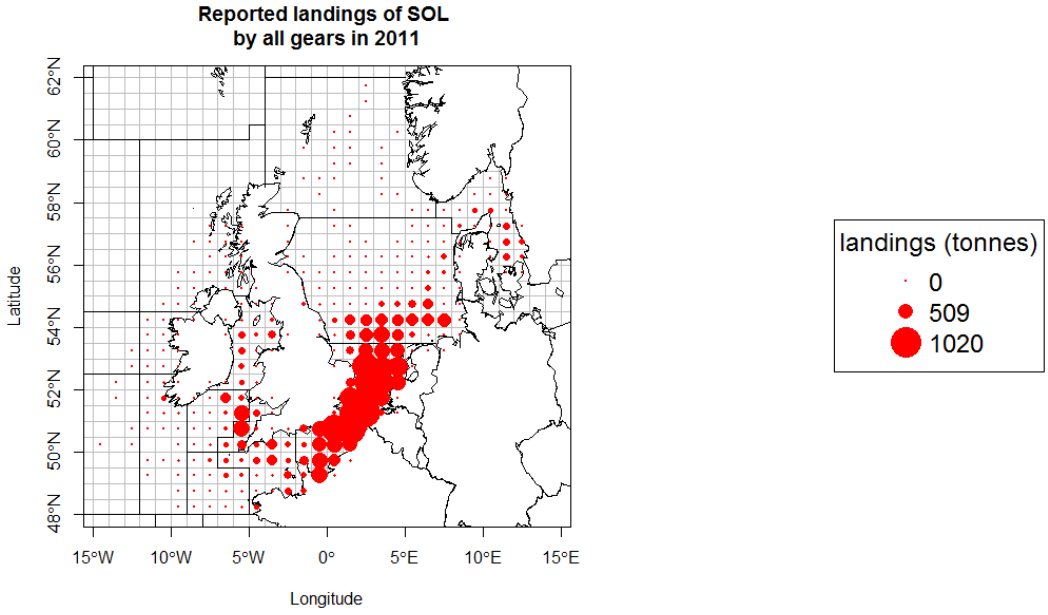

Figure 5.7 EU landing distribution for sole in 2011

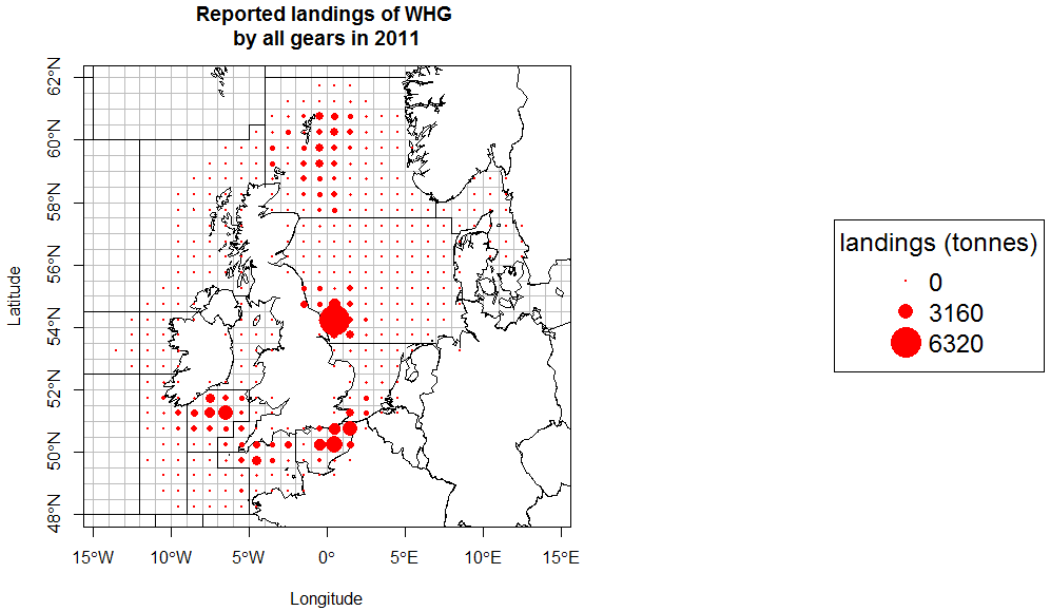

Figure 5.8 EU landing distribution for whiting in 2011(The large value off the English east coast may be in error as it appears to be greater than expected for total declared ICES catch).

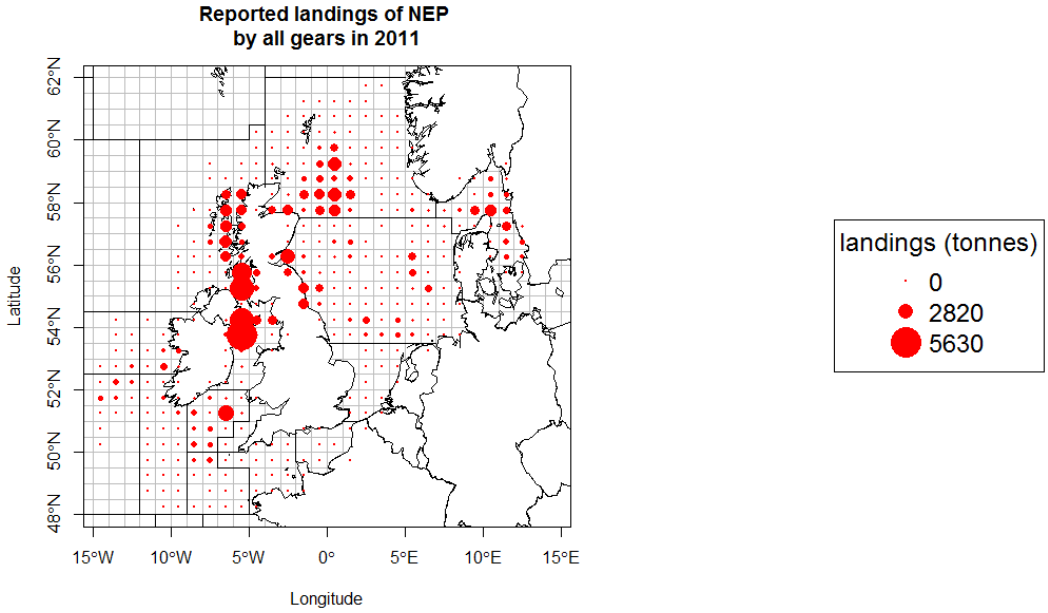

Figure 5.9 EU landing distribution for *Nephrops* in 2011

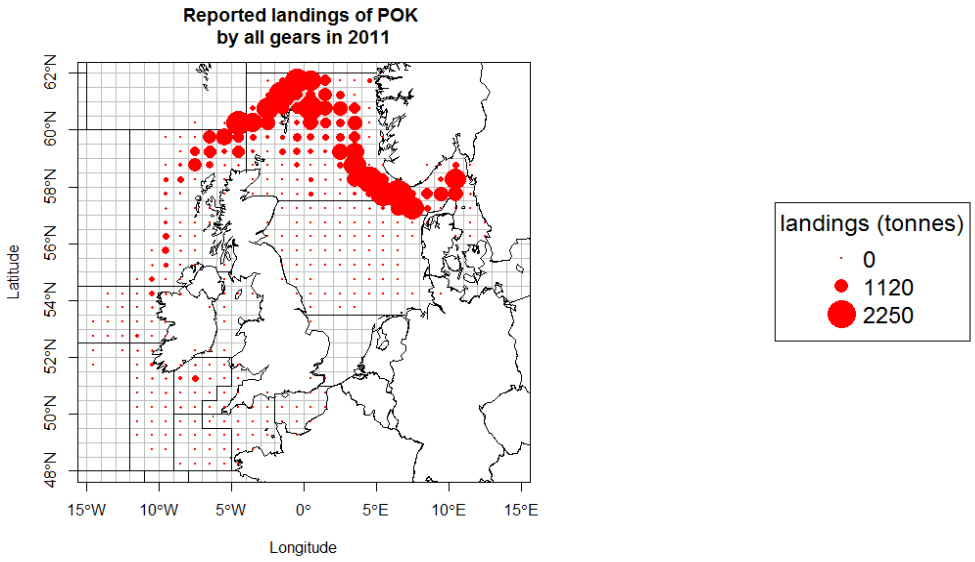

Figure 5.10 EU landing distribution for Saithe in 2011

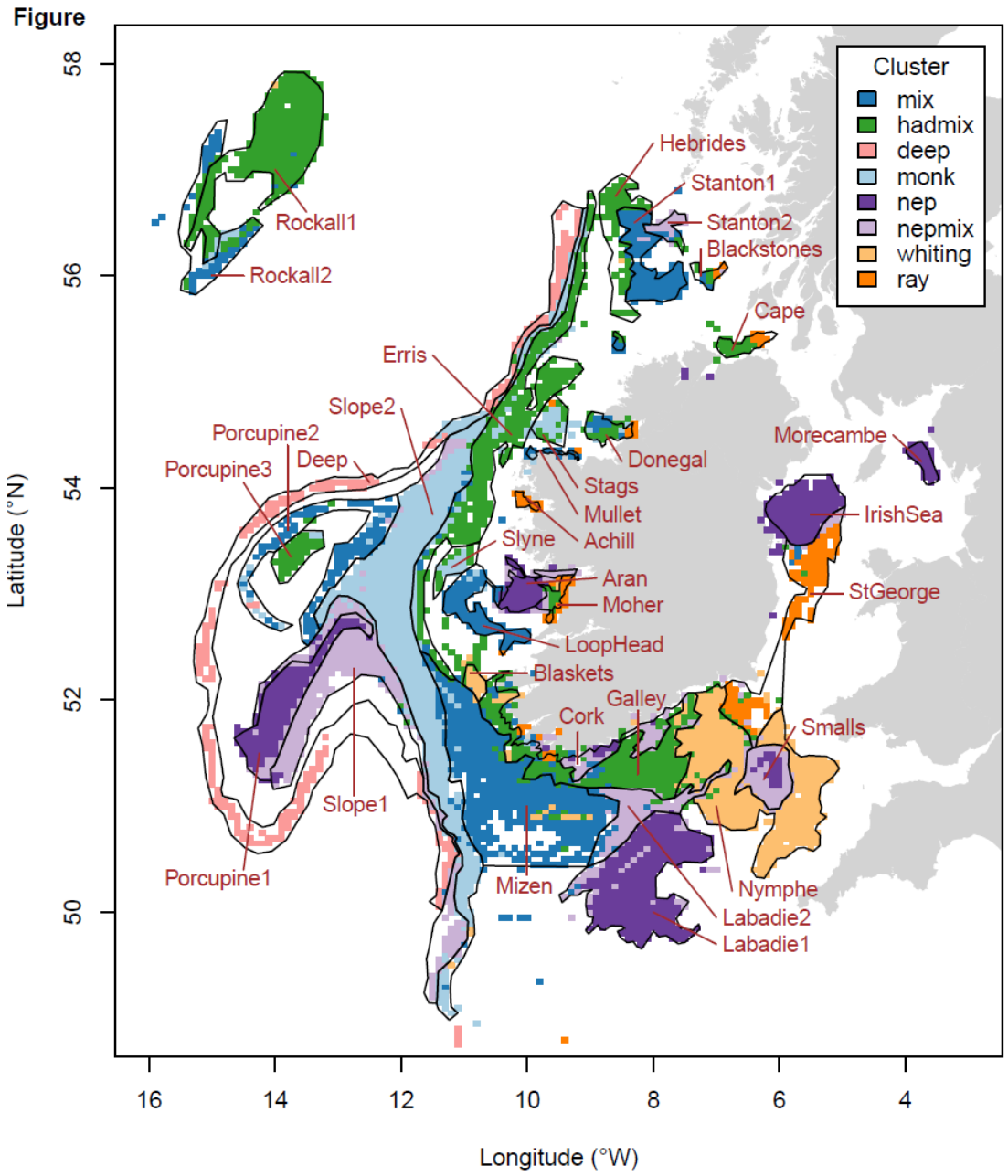

Figure 5.11 Broad area classifications based on main target species from clustering analysis of logbook data linked with VMS (Gerritsen et al, (in press)).

5.3 VARIATION IN FISHING BEHAVIOUR

Fleets operating in European waters exhibit various types of movement behaviour ranging from localised movement in small vessel coastal fisheries, to larger scale movements between sea areas.

A number of fleets hold fishing entitlements (through licence, quota holdings and days at sea eligibility) for areas beyond their current or customary fishing pattern. The flexibility to alter area of fishing operations, and sometimes target species remains a valued, and at times important, dimension to maintaining economic viability.

Alterations in fishing pattern arise for a number of reasons including, inter alia, biological drivers (fish distribution, seasonality in fish condition etc), market forces, economic factors and changes induced by regulations. Examples are provided below:

Biological and environmental

- Irish Sea *Nephrops* fleet which may fish from time to time in the North Sea or West of Scotland (Figure 5.9) owing to changes in abundance.

- Changing to different *Nephrops* Functional Units – many Scottish TR2 vessels move between Functional Units in areas IV (North Sea) and VI (West of Scotland) (Figure 5.9). This has historically applied to smaller vessels on a seasonal basis (between east coast of Scotland, the Clyde and Minches) but more recently, has applied to larger offshore vessels working the Fladen grounds and offshore parts of the South Minch seeking better returns. In these cases, the transfer can be for short or long periods.

- Periodic 80mm whiting fishery in the central North Sea by vessels which usually fish in IVc or VIId (Figure 5.8)

- Directed saithe fleet with entitlements in North Sea and West of Scotland (Figure 5.10)

- Seasonal fluctuations in availability of species – for example, vessels will spend some time in area VIa (West of Scotland) during periods of quarter 1, 3 and 4 when concentrations of haddock have (historically) increased on traditional grounds. A similar situation has arisen in quarters 2 and 3 in specific areas within area IV.

- Weather – during extended periods of poor weather vessels may move from North Sea to West of Scotland management area (or vice versa)

Economic and market factors

- Mixed demersal fishery with vessels moving across areas to meet market demand – where vessels have had available species quota both in areas IV and VI, it has been quite common to move across areas during a trip to utilise available species quota, making effective use of time away from home and days at sea allocations.

- Crossing over from TR1 to TR2 for economic or availability issues – vessels with whitefish quota allocation transfer between TR2 and TR1 methods at various times. In doing so, they may also move freely between areas IV (North Sea) and VI (West of Scotland).

Effects of Regulations

- Vessels displaced from Faroes by the failure to negotiate access arrangements have had to move to areas where they have limited opportunities (species quota) and in order to maximise these, move between management areas IV (North Sea), VIa (West of Scotland), VIb (Rockall) and deep-water fisheries (across management areas).

- Displacement of Deep Water vessels from outside to inside the cod recovery zone

- Gear conflict – To the north west of Shetland, Scottish mobile gear vessels are now having to avoid static gear which moved into the area following earlier reductions in mobile gear effort (for a variety of reasons). To avoid conflict, the mobile gear vessels have to seek opportunities elsewhere, usually moving between areas IV (North Sea) and VI (West of Scotland).

- To avoid catching (and subsequently discarding) species which are locally abundant but no TAC or quota is available. This has been the case where vessels have been encountering large catches of cod in area VI (West of Scotland) where Catch Composition Rules prevent them from retaining this species onboard. Rather than continue to catch, and discard, unwanted fish, the vessels have tried to move on to other grounds, often into another management area (IV – North Sea). A similar situation has also been observed in relation to vessels catching whiting in area VIa (West of Scotland).

- Days at Sea restrictions which influence selection of fishing grounds

- Cod Recovery Plan – with effort restrictions in the Cod Recovery Zone, some vessels try to extend fishing opportunities by moving to areas outside the CRZ such as deeper waters to the north and west of Scotland, and Rockall.

These examples suggest that it would be unwise to assume a wholly static spatial pattern for the demersal fleets as diverse drivers can result in quite significant year to year variability. Depending on the displacement effects of offshore wind-farms, other marine renewable installations and the establishment of a network of marine protected areas (in part to meet MSFD obligations) this variation may increase in coming years. Whilst recognising the difficulty of anticipating future responses by fishermen to changing biological, environmental or management factors, there are nevertheless insights that can be gained from these observations which may help to shape future management.

6 AREA BOUNDARIES OPTIONS

Based on the areas defined by the Commission (Section 4.1) this EWG considered appropriateness of the boundaries between the areas based on two main criteria, considerations of stock boundaries, and selection of regions with coherent fisheries.

6.1 Boundary between North Sea and Channel; boundary between Celtic Sea and Channel

In this section the question is addressed whether ICES Subarea VIId (Eastern Channel = EC) should be managed as part of the management area of the North Sea (NS), or, alternatively together with the ICES Subarea VIIe (Western Channel = WC) in a common Channel management area. In addition, the boundary between the WC and the Celtic Sea (CS) management area is discussed. In other words, three possible boundaries are relevant: the one between NS and EC, the one between EC and WC, and the one between WC and CS.

6.1.1 Biological considerations

Cod:

Biologically, two cod stocks are recognised: one whose distribution area is NS + EC, and one covering CS + WC (VIIe-k). The first stock (NS + EC) is managed under the NS cod management plan (including effort regime), with separate TACs for the EC and NS part, and the second (CS + WC) is managed by (one) TAC only.

Haddock:

Biologically, only one haddock stock is recognized for the EC+WC+CS (ICES Subarea VIIb-k), managed by a TAC covering ICES Subarea VIIb-k, VIII, IX and X; EU waters of CECAF 34.1.1. It should be noted that haddock is only very sporadically fished in EC as the EC is thought to be too shallow; therefore only very low catches of the stock are taken from the EC.

Whiting:

Biologically the situation for whiting is similar to the one for cod, with two stocks: one whose distribution area is NS + EC, and one covering CS + WC (VIIe-k). The NS stock is managed by a TAC which covers area IV only; whereas the combined areas EC + WC + CS (ICES Subarea VIIb-k) are covered by one TAC. This is currently inconsistent with the stock distribution and ICES have recommended that VIId be managed separately, alongside area IV.

Sole:

Biologically, there are four separate stocks: one in NS, one in EC, one in WC, and one in CS (VIIfg) . Each of these is managed by a separate TAC.

Plaice:

Biologically, as with sole, there are four separate stocks, one each for NS, EC, WC, and CS (VIIfg). However, in quarter 1 (Q1) individual fish from the NS stock as well as from the WC stock migrate into the EC area to spawn, such that in Q1 50% of the fish caught in EC belong to the NS stock and 15% belong to the WC stock. Management is by one TAC for EC + WC, and one TAC for NS.

Anglerfish:

Biologically, anglerfish stocks (comprising of two species *Lophius piscatorius* and *L. budegassa*) are considered to cover the ICES divisions VIIb-k and VIIIa,b,d. However, the management is done by two different areas with two separate TAC's, (VII and VIIIa,b,d,e). It should be noted that anglerfish is only very sporadically

fished in EC as the EC is thought to be too shallow; therefore catches of anglerfish from the EC are low.

Herring:

Biologically, one herring stock is recognised whose distribution ranges across EC + NS. The stock is managed by one overall TAC separated in two separate area allocations one for NS and one for EC (set to manage catches of the "Downs" population). It should also be noted that although not assessed as such, there is a separate TAC for divisions VIIe + VIIf.

Sprat:

Sprat in the NS is considered one stock and managed through one TAC. The stock structure of sprat populations in the Celtic Seas eco-region is not known; ICES provides advice in relation to sprat in the channel (VIIde) but does not advise that VIIde is considered a discrete stock, with further work required to establish stock structure.

Non-quota species:

A number of valuable non-quota species exist in the Channel, such as seabass, red mullet, cuttlefish, squid, and scallops (separate stocks of scallops are managed locally/nationally). Red mullet consists of two stocks: one northern stock whose distribution covers EC + NS, and a southern stock distributed across WC + CS + BoB (Bay of Biscay). Seabass live mostly in the Channel and spawn in the west, crossing the border between EC and WC; ICES WGNEW intends to consider stock structure in their October 2012 benchmark; tagging studies indicate movement between NS and Channel.

6.1.2 Fisheries considerations

The fisheries/fleets/metiers targeting cod (Figure 5.2), whiting (Figure 5.8), herring, sprat and flatfish (Figures 5.6 and 5.7) in the northern NS (IVa and b) are different from those targeting/bycatching the same species in the Channel + the southern NS (IVc). Owing to the management divisions already in place (i.e. the boundary between EC and WC, with only EC under effort restrictions of the current cod plan) the fisheries in the WC are generally separate from those in EC; though some vessels operate across the channel division. Note that otter trawlers fishing in EC are regulated by the cod effort regime, whereas the same effort restrictions do not apply to vessels in the WC; though these vessels are subject to the western waters regime.

Again it should be noted that haddock and anglerfish are only very sporadically caught in the EC.

Small boats (<10m) catch significant amounts of cod (15% of the total caught in the Channel), sole (10-20%), and plaice (10-15%). These vessels cross the boundary between EC (VIId) and IVc; however, there is less of an issue with the boundary between WC and EC as they are mostly fishing on different stocks.

Catches of sole and plaice are low near the boundary of EC and WC (Figures 5.6 and 5.7) suggesting a separation of the fishery at that boundary.

6.1.3 Pros and Cons of having the EC managed together with the NS as opposed to with the WC.

Based on biological considerations concerning cod, whiting, and herring (and red mullet), the EC should be managed together with NS (rather than with WC); a split between NS and EC would potentially result in two different management regimes for each of these stocks. Based on biological considerations concerning sole, it does not matter where the management boundary is placed, between the EC and NS or WC and EC, because the stocks are discrete. Therefore for all these species there is no strong basis to join EC and WC. Because of the strong mixing of NS and EC plaice in the EC (and to a lesser extent the mixing of WC and EC plaice in the EC) the EC should ideally be managed together with NS as well as with WC. However, biological considerations concerning cod, whiting, and herring suggest stronger linkage between the WC and CS than the WC and EC; therefore considering the majority of the main stocks it is better to join just the EC with NS. With regards to plaice this does not fully take account of the stock and fishery interactions but is the preferred option because 50% of the plaice caught in EC in Q1 derives from NS, whereas only 15% in EC in Q1 derive from WC. Nevertheless, the disadvantage of separating EC from WC from the point of view of the WC plaice stock is substantial, because a significant proportion of the WC plaice stock resides in the EC in Q1. With regards to the biological and fisheries considerations concerning haddock and anglerfish, there is no disadvantage of a boundary between EC and WC as these stocks are only caught in small quantities in the EC and not subject to directed fisheries. Biological considerations for sprat are currently unknown due to a lack of knowledge on stock discrimination.

Based on fisheries considerations, although the same fisheries may operate in EC as in WC, there is no big disadvantage to have a boundary between EC and WC because the fisheries have already been operating differently in both areas owing to the current differences in management regimes.

6.1.4 Conclusion:

If a boundary needs to be established somewhere between NS and CS, it is best to locate that boundary between EC and WC (i.e. manage EC jointly with NS rather than with WC). Most considerations do not pose any disadvantage to this option. Only the biological considerations with regards to plaice (and uncertainties in relation to sprat and seabass) pose a potential disadvantage to separating EC from WC; however, the disadvantage to plaice of separating EC and NS is greater. The alternative option of joining EC with WC and locating the boundary between NS and EC would pose a disadvantage for the cod, whiting, herring, and red mullet stocks because these single stocks would then each be split over two separate area-based management regimes at relatively small spatial scale.

Should there be a boundary between WC and CS?

Based on biological considerations concerning cod, whiting, haddock, anglerfish and herring (and red mullet) there should not be a boundary between WC and CS because this would imply that single stocks are managed by two different management-area-based regimes. There are no advantages (but only disadvantages) of a boundary between WC and CS.

Conclusion: There should be no boundary between WC and CS; WC should be managed together with CS.

6.2 Boundaries between North Sea, West of Scotland and Celtic Seas

6.2.1 General Considerations

The current areas have some disadvantages which leads to consideration of alternative management areas for NS, WoS and Celt Sea (See Figure 5.12). For the purposes of a mixed fisheries management plan, redefinition of the current ICES/RAC areas has a number of positive and negative consequences. The EWG considers there may be advantages in new proposed area definitions which are primarily based on a broad clustering of fisheries activities based on gear types, target species, and spatial activity. The principle reason for redefinition of the management area is therefore the activity of the key actors, those being 'managed'. This new focus also aligns management much more directly with identifiable economic units.

This proposal does raise a number of issues. Currently, many of the fleet segments operate across different management areas, these can have significant differences in fishing opportunities and other regulatory constraints. Whilst this is not an issue for managers, as vessels must conform to the regulatory frameworks in each area, it does present potential issues for fishers. The newly proposed mixed fisheries management areas join together existing management areas, within which they fish. This however, does split some stocks between new management areas. This is particularly an issue in the North Sea, West of Scotland and Celtic Seas. For example, the proposed three fisheries areas which extend the Celtic Seas into VIa splits VIa and combines Via north with IVa North and split the NS (See Figure 5.12). This change effectively splits the TAC areas for a number of demersal species in both VIa and IV (cod Figure 5.2, haddock Figure 5.4, whiting Figure 5.8 etc.), though as can be seen in these figures the fisheries in these areas are already separate. Due consideration needs to be given to future management approaches that are specific to the newly defined management areas and deal with the straddling stocks. Nevertheless, it is considered that the advantages of focusing on the coherent areas for fishers outweighs the problems for multi-area TAC allocation. The arguments are developed below.

6.2.2 Boundary issues between WoS and NS

Currently, the east-west delineation between IVa and VIa is at 4 degrees west. Broadly speaking, the fisheries operating either side of the VIa and IVa boundary could be clustered as follows: Groups of vessels targeting haddock, whiting and cod with demersal trawls on the shelf; vessels targeting anglerfish and megrim along the shelf slope/ break using otter trawls; vessels targeting saithe along the shelf break using otter trawls; vessels targeting anglerfish along the shelf slope using gillnets.

For shelf demersal fisheries, there are greater technical similarities (overlap and exchange) in activity between the northern part of VIa and IVa than between the activity in VIa North and VIa south, where there is little latitudinal exchange in activity of shelf demersal fisheries. Individual vessels operating in the Northern North Sea also operate in the northern part of VIa targeting similar species. Demersal activity in the southern part of VIa tends to be closer to the activity (same vessels) in VIIb.

The current split between VIa and IVa (4 degree line) is unlikely to act as a delineation between stocks. Landings and survey distribution data tends to support

this view. Analysis of logbook landings data linked to VMS data shows that there are no clear east-west separation between landings of cod, haddock, megrim and monkfish at the point of the 4 degree line. Recently ICES (2011) redefined the megrim stock area based on the lack of any clear delineation east and west of the 4 degree line, the saithe stock was dealt with in a similar way a number of years before. However, it should be noted that while there is little evidence showing a discrete break in landings across the boundary, this does not necessarily imply the presence of single VIa and IVa stocks for each of the key species across the broader VIa North and IVa North proposed area.

6.2.3 Boundary issues between WoS and CS

Following on from the option to split VIa into Northern and Southern components, combing the southern component of VIa together with the wider Celtic Seas (VII-ek), could be considered as a more appropriate area definition in terms of fishing activity. Cluster analysis of spatially refined (using VMS) Irish logbook data undertaken by Gerritsen et al (in press) and grouped into principal target species is provided in Figure 5.11. This shows that fishing activity (at least associated with the Irish fleet) extends from VIa south towards the Celtic Seas. Enlargement of the Celtic Seas area by including the southern component of VIa is considered appropriate. Enlargement of this area reduces some transboundary issues for stocks (between VIasouth and VIIb).

6.2.4 Boundary issues between the proposed Northern Shelf area of IV and Southern North Sea

The merger of the northern part of VIa and the Northern part of IV addresses a number of fishery and potential stock issues. However, the removal of the 4 degree boundary alone, implies the creation of a large area extending from the eastern Channel to the west of Scotland involving diverse fisheries (trawling, beam trawls, gadoid dependent fisheries, flatfish dependent fisheries etc) and a diverse grouping of key players. It is questionable whether this would facilitate constructive dialogue in the development of area management plans. STECF discussed the possibility of adding a boundary part of the way down the North Sea effectively creating a new, Southern North Sea Area. It is unlikely that a simple boundary based on latitude would serve the purpose of creating a sensible solution and would likely result in several stock units being divided. However, a boundary more closely linked to recognised physical, hydrographic and biological factors appears to offer a more defensible solution, albeit that the resultant boundary would describe a broadly diagonal line. A stepwise line extending from the east coast of south Yorkshire to the Northern Danish coast was first considered but examination of distribution of EU landings suggested area overlaps of some key species such cod and plaice were intersected by the line. Figure 6.1 shows a boundary based on the 50m contour which aligns more closely with a number of observed environmental features (the Flamborough front system etc.) and appears to address the majority of the stock issues. Figures 5.1 to 5.10 indicate fish distributions which are better served by the boundary informed by depth. This split in the NS aligns closely with the NNS/SNS split documented by ICES under WGINOSE (ICES 2012). In terms of the groupings of key players, the creation of a southern North Sea area would generate a forum with distinct issues from those prevailing in the northern shelf area.

Taken together we consider that the proposed boundary changes increase coherence of players within each area, potentially making it easier to resolve issues.

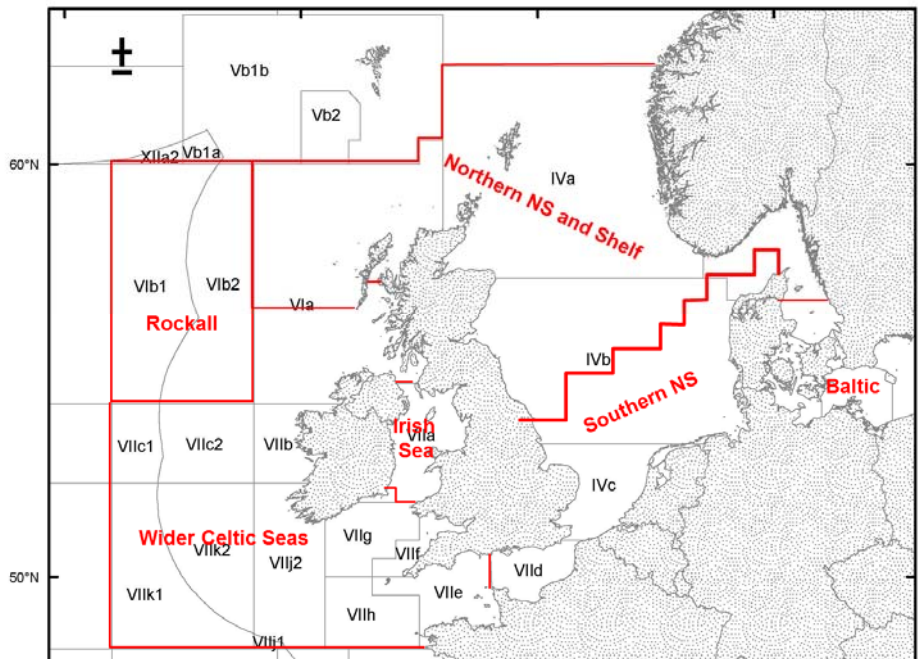

Figure 6.1 Potential areas for management, boundary options in red and ICES areas in black. The dividing line in the central NS is aligned to ICES rectangles and approximates the 50m contour.

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6.3 Boundary between NS and Baltic

6.3.1 Definitions of options

Four options can be considered for the boundary between the North Sea and the Baltic. The North Sea ecoregion can be 1) limited eastwards to the narrow ICES area IV, or 2) extended to include the Skagerrak (area IIIaN) or 3) include the whole of area IIIa (Skagerrak + Kattegat). Or finally, Kattegat (IIIaS) can be considered on its own as being a unique transition area (4). Finally, the question of whether the current administrative boundaries themselves are fully appropriate (see below) is discussed.

It is to be noted that Kattegat is named differently depending on the point of view. Seen from the Baltic, Kattegat is usually denoted “Subdivision 21” originally based on the area classification of the Baltic Fishery Commission, but seen from the North East Atlantic Kattegat it is denoted “Subdivision IIIaS” based on the NEAF system.

It is also important to underline that all Skagerrak and Kattegat boundaries cross diagonally through several ICES rectangles, and these mismatches have repeatedly created issues in terms of monitoring of catches for TAC uptake and stock assessment.

These different options are discussed below.

6.3.2 Biological considerations

The boundary between Skagerrak and Kattegat is closely but not entirely based on hydrographical conditions, with subsequent issues for stocks identity. In terms of hydrographical features, the Skagerrak is largely a prolongation of the North Sea with regards to depth and salinity, with deep waters all along the Norwegian coast and shallower areas along the Danish coast,and the Swedish coast. However, the main changes in hydrography are not found at the border between Skagerrak and Kattegat, but rather somewhere more southerly, around the island of Læsø in the Northern Kattegat. Around this area, the salinity drops very rapidly (Figure 6.2). This, in combination with a large area of shallower waters around this island, constitutes a kind of natural hydrographical barrier.

Indeed, many demersal fish stocks are found either north or south from this cline, rather than following the administrative boundaries.

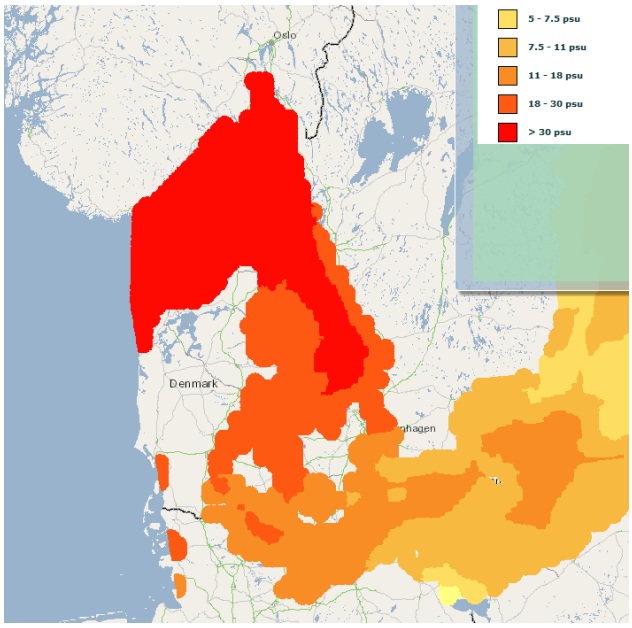

Figure 6.2.Modelled bottom salinity.http://maps.helcom.fi/

Because of this natural separation, the Kattegat constitutes a true transition area between the North Sea and the Baltic, and cannot be easily allocated to either area.

Below are summarised the main features of the stocks exploited in area IIIa

- COD: Cod in Skagerrak is considered the same stock unit as the North Sea, whereas cod in Kattegat is a stand-alone stock unit, although juvenile cod originating from the North Sea are caught in the entire Kattegat. Main catches of cod in Skagerrak are taken in the Western and central areas, whereas Kattegat cod are caught on patchy locations both North and South within Kattegat.
- *NEPHROPS*: *Nephrops* is the main commercial species in area IIIa, and is distributed over large grounds around the centre of the area, i.e. from the central/Eastern Skagerrak to the central Kattegat. These grounds are still

considered as two distinct functional units (one in Skagerrak and one in Kattegat), but they are now assessed as one unique stock.

- PLAICE: Historically, plaice in the North Sea had always been considered as one stock, whereas plaice in IIIa was considered as a separate stock. However, in 2012 ICES suggested a revision of these stock boundaries, and considered that plaice in Skagerrak, which for the largest part are fished at the Western entrance along the Danish coast, was likely connected to the North Sea, whereas plaice in (South) Kattegat was more related to the Belt Sea and Sound (areas 22 and 23)
- SOLE: The stock of North Sea sole do not expand beyond the sole area IV. In area IIIa, the sole stock includes the Skagerrak, the Kattegat and the Belt Sea, but the largest part of the fishery takes place in the South Kattegat and the Belt.
- SAITHE: Saithe in Skagerrak is considered the same stock unit as the North Sea, and main catches of saithe in Skagerrak are taken in the Western and central areas along the Norwegian deep. There are only limited catches of saithe in Kattegat
- HADDOCK. Haddock in Skagerrak is considered the same stock unit as the North Sea, and main catches of haddock in Skagerrak are taken around the Western boundary to the North Sea. There are hardly any catches of haddock in Kattegat
- WHITING: Whiting in area IIIa is assessed as a single stock unit separately from the NS stock, but catches are mainly taken in the Skagerrak.
- PANDALUS: Pandalus (Northern shrimp) is assessed as one stock covering Skagerrak and area IVa East along the Norwegian coast, and the fishery is located in the Norwegian deeps.
- HERRING: Herring in area IIIa is a mixture of Western Baltic Spring Spawning herring, that spawn in the Baltic but performs summer feeding migrations across IIIa and up to the Eastern North Sea, and North Sea Autumn Spawning herring which enter into Skagerrak and Northern Kattegat as juveniles and return to the NS to joint the adults. The ICES advice for that area therefore comprises considerations of both North Sea and Baltic stocks.
- SPRAT: Sprat distributed in Skagerrak and Kattegat is managed as one stock unit. The sprat catches are taken predominantly in Kattegat, to a large extent close to the Skagerrak border.

The Figures 6.3below display the location of the main species targeted by the Danish fisheries

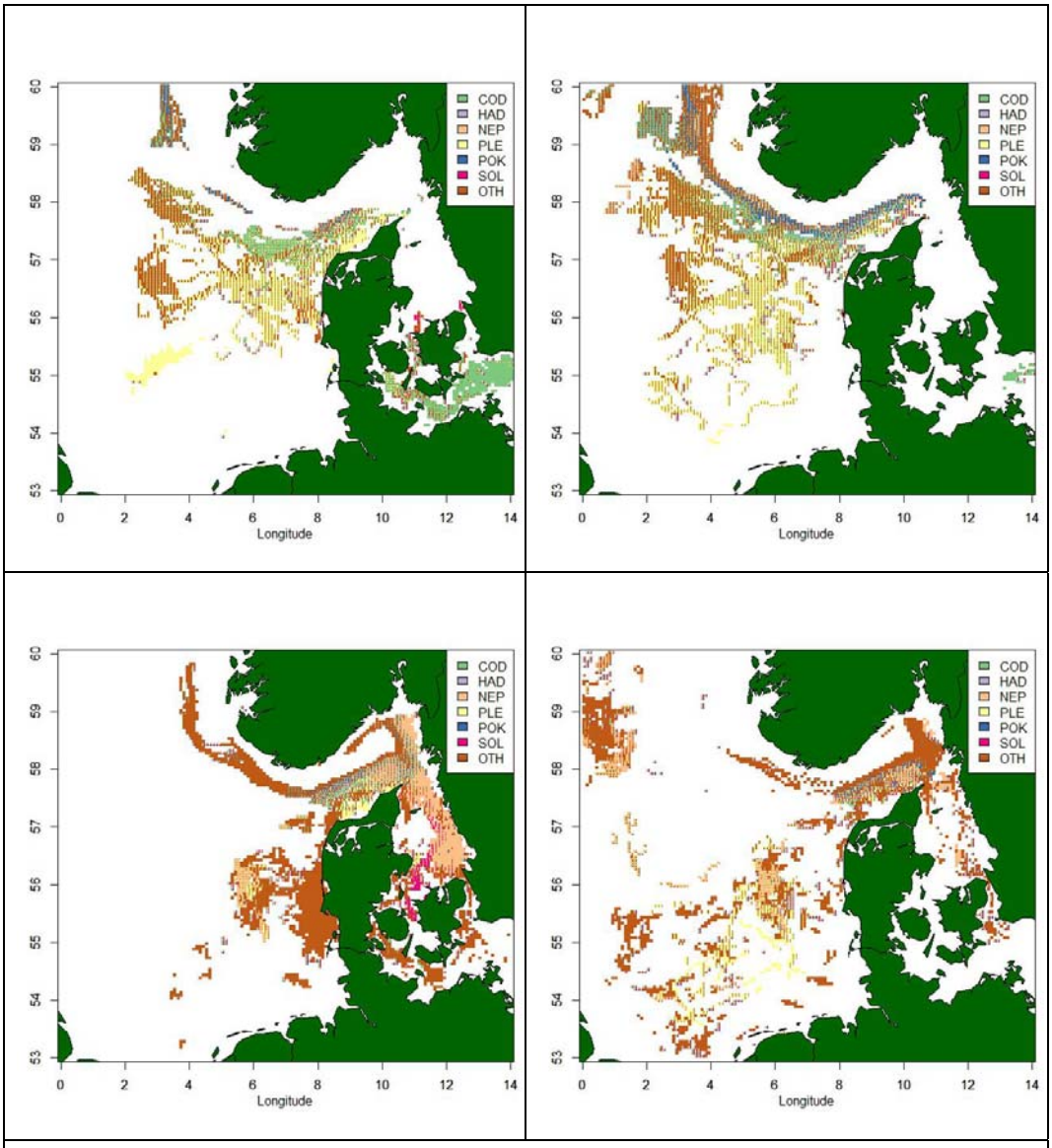

Figure 6.3: Main target species (in value) of the 2010 Danish trawl and seines fisheries (trawl and seines >=100 mm) from linking VMS and logbook data (Bastardie et al., 2010). Left : vessels 15-24m. Right : vessels 24-40m. Top :TR1 (mesh sizes >=100 mm). Bottom : TR2 (mesh sizes < 100mm).

6.3.3 Fishery considerations

Kattegat and Skagerrak are predominantly exploited by Denmark and Sweden. In addition, there are some Norwegian and Dutch fisheries in the Skagerrak, and some German fisheries in the Kattegat. The majority of these fisheries are carried out by small to medium size vessels with homeports within the same waters, and therefore the two areas have often been treated together in terms of management. In particular,

demersal fisheries of Skagerrak and Kattegat are covered by the same Working Group within the North Sea RAC. Similarly, these areas would be addressed together for the management of pelagic resources, where they are covered by the Pelagic RAC whereas pelagic fisheries in the Baltic Sea are addressed within Baltic Sea RAC.

Danish vessels are considered to have their main activity (revenue) in the North Sea, however it has been shown that 5 to 15% of their effort and revenue is linked to the Skagerrak area (average 1998-2005; Andersen and Andersen 2007, WD to FP6 CAFÉ project).

Similarly, the vessels belonging to Skagerrak are resident to Skagerrak to a very large extent, with the majority of vessels having all their revenue in Skagerrak itself. (Beyer et al 2012). The more mobile vessels travel to the North Sea but very little to the Kattegat. The main fishery in Kattegat is *Nephrops* trawling, and *Nephrops* vessels from the Kattegat would also travel to the Skagerrak.

Globally, the importance of fisheries activities in Kattegat have continued to decrease, and they represented less than 5% of the value of total Danish fisheries in 2011, of which *Nephrops* represent 57%, sole 13% and sprat 9% (Danish AgriFish Agency).

6.3.4 Pros and Cons / Conclusions to options

The pros and cons of setting the boundary between North Sea and Baltic Sea according to various lines are summarised here:

- (1) Setting the boundary at the border between North Sea and Skagerrak. This option seem largely inappropriate, given that many of the main fisheries, both demersal and pelagic are obviously straddling across the Eastern North Sea and the Skagerrak, and the main North Sea fish stocks extend into the Skagerrak.
- (2) Setting the boundary at the border between Skagerrak and Kattegat. This option would appear fairly appropriate for a number of demersal fisheries and stocks. However, the main issue would concern the management of *Nephrops* stock, which is the predominant economic resource. That would also maintain the split of the likely biological linkage between the North Sea cod and the Kattegat cod stock. The traditional management of pelagic fisheries, where IIIa is a whole unit, would be also be affected to some extent.
- (3) Setting the boundary at the border between Kattegat and Western Baltic. This option would allow considering the main *Nephrops* fishery as one unit. The main remaining issues would be linkages between sole and plaice stocks with the Belt Sea area, as well as the possible boundary effects of Kattegat cod with the Belt Sea and the Sound. This option would also be sensible with regards to the current RAC area, where the Skagerrak-Kattegat are discussed in the NS RAC .
- (4) Maintaining Kattegat as a separate management unit distinguished from both the North Sea and the Baltic Sea. This option is the one currently in place for the cod management plan. Whereas this makes sense in terms of biogeography, it does not address the main issue, the artificial regulatory split that this creates with regards to the predominant *Nephrops* fishery.

Meanwhile this maintains a complicated regional setup which needs to account specifically for an area of limited size and smaller economic importance.

- (5) Changing area boundaries. Replacing the current administrative boundary between Skagerrak and Kattegat by e.g. a horizontal around 57º N might probably make some sense in terms of stock identity and actual transition between the North Sea and the Baltic. However, it is evident that such a revision would implicate dramatic and wide-ranging political issues.

In summary, the STECF EWG considers that all options except the first have some merits and could be considered meaningful. However, in consideration of the economic predominance of *Nephrops* and pelagic fisheries, where IIIa is traditionally considered as one management unit, and in consideration of the general decline of importance of fisheries in Kattegat, the EWG suggests the third option is preferable i.e.to include both Skagerrak (IIIaN) and Kattegat (IIIaS) as part of the extended North Sea management area. This, however, should not prevent more specific and local management considerations to be taken for the individual sub-areas.

6.4 Northern Boundary between Irish Sea and West of Scotland

6.4.1 Definitions of options

The northern boundary between the Irish Sea and West of Scotland (Division VIIa and VIa) lies within the North Channel (Figure 6.4), a deep channel area with low bottom trawl activity. The only fishing fleet segment that operates across the management line, potentially exploiting different stocks, is a semi-pelagic whitefish fleet (TR1). The effort for this fleet has declined significantly and now comprises only four vessels. The main part of the catch is cod and hake. There are no proposals to move this management line.

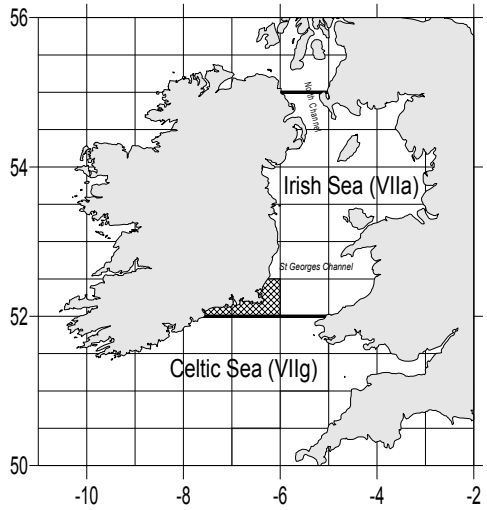

Figure 6.4 Map indicating the existing boundaries for the Irish Sea (VIIa) (bold black lines) and the proposed rectangles to be included in the Celtic Sea (VIIg) (shaded).

6.4.2 Definitions of options

6.4.3 Biological considerations

The main assessed species caught in the North Channel area are seasonal catches of cod (Figure 5.2), hake and herring.

Recent tagging studies of cod stocks in ICES Divisions VIa, VIIa and VIIe–k suggested that there is evidence of limited seasonal migration of cod into neighbouring regions, but that most fish stay within the Irish Sea management area (Bendall et al. WD9, ICES WKROUND2 2012). During the first two quarters of the year the adult cod are distributed throughout the western Irish Sea, but later in the year, in quarters 3 and 4, the cod have a very restricted distribution, confined to deeper waters in the northern and southern channels. Tagging studies have demonstrated movements of cod between Division VIa and VIIa. Most recaptures in VIIa from cod tagged in VIa have come from the North Channel.

European hake is widely distributed over the Northeast Atlantic shelf. Although there is no clear evidence of multiple populations in the Northeast Atlantic, ICES assumes two different stock units. The Northern stock is distributed over a wide area and include IIIa, Subareas IV, VI, and VII, and Divisions VIIIa,b,d (Northern stock).

Significant migration and mixing of herring that originate from different spawning areas occurs to the west of the British Isles. An EU funded study, WESTHER, found little evidence of discreet structuring of juvenile and adult herring west of the British Isles, outside the spawning seasons. Evidence did, however, indicate population structuring by spawning time and spawning sites. A combined assessment of the three herring stocks VIaN, VIaS/VIIb,c and VIIaN (the Malin Shelf metapopulation) was explored by ICES (SGHERWAY 2010), but recommended that whenever subcomponents of the metapopulation differ considerably in abundance, sustainable management is impossible for the smallest subcomponent and that the Irish Sea (VIIaN) stock should continue to be assessed and managed separately.

6.4.4 Fishery considerations

All fishery activity in the North Channel is from seasonal fisheries targeting scallops, whitefish and herring. The scallop fishery (mostly using TR2 gear) targets local scallop populations and has very little bycatch of fish. The pelagic fleet occasionally targets herring in the channel, but it generally amounts to a small proportion of the VIIa(N) annual landings and is on herring migrating to the spawning grounds further south. Both these fisheries could be managed at fishery level, with little consideration required for specific areas or boundaries in the Irish Sea. A semi-pelagic whitefish fleet (TR1) also operates a seasonal fishery in the North Channel (Figure 5.3), mostly targeting cod and hake. The effort in this fleet has declined significantly and now comprises only four vessels. Hake is a widely distributed stock occurring across a number of management areas. Recent tagging information indicate that the cod caught in the North Channel is mostly likely from the Irish Sea, although some Clyde cod (considered part of the VIa cod stock) might also be caught. The size of catches and level of fishing activity does not necessitate any consideration for shifting or re-evaluating the management line.

6.4.5 Pros and Cons / Conclusions to options

There is little evidence to suggest any major advantage or disadvantage of changing or shifting the northern boundary of the Irish Sea. The only species where stocks from different management areas could be exploited in this area is cod, but effort is very low and not likely to increase with current fishing opportunities.

6.5 Southern Boundary between Irish Sea and Celtic Sea

The southern boundary between the Irish Sea and Celtic Sea (Division VIIa and VIIg) lies within the southern end of the St George's Channel (Figure 6.4). Fishing activity is relatively low within the St Georges Channel, but increases significantly towards the sound and around the boundary area between the two management areas. The proposal is to include the two most southwestern rectangles (off the Irish southeast coast) into Division VIIg (see shaded rectangles in Figure 6.4).

6.5.1 Definitions of options

6.5.2 Biological considerations

The main assessed species caught around the southern boundary area are cod, anglerfish (Figure 5.1), haddock (Figure 5.4), megrim (Figure 5.5), plaice (Figure 5.6, sole (Figure 5.7) and whiting (Figure 5.8). *Nephrops*(Figure 5.9) are limited to a muddy habitat and the distribution of suitable sediment defines the species and stock distribution, i.e., eastern (Functional Unit 14) and western Irish Sea (FU 15) (Figure 6.9).

Stocks of cod, haddock, plaice, sole and whiting are generally defined within the Irish Sea management unit. Although there is evidence of movement between management areas for cod, haddock and whiting in particular, the magnitude of migration is thought to be low. Stock identification problems for plaice and whiting, in particular, are generally related to an east west split within the Irish Sea as opposed to across management areas.

Anglerfish and megrim are widely distributed stocks that cover nearly all the area represented in these figures. The stock identity of elasmobranch species, caught around the southern boundary of the area, is more uncertain.

6.5.3 Fishery considerations

There are a number of fisheries operating in the St Georges Channel. Fishing activity in the St Georges Channel is mostly restricted to a ray fishery (north part (Figure 5.11)) and a beam trawl fishery. The area just south of the management line is characterised by a wide range of fishing activity and fleets.

The spatial distribution of these fisheries appears to mostly exploit stock units within a particular management area, e.g., plaice and sole by the beam trawl fleet. *Nephrops* vessels migrate in and out of the Irish Sea, the extent of the movement depending on fishing opportunities and catch rates. The TAC for *Nephrops*is set for the whole of area VII and management does not in general constrain the movement of vessels between functional units (the unit of assessment and advice). This is an issue for wider consideration and not specific to the Irish Sea management area.

6.5.4 Pros and Cons / Conclusions to options

The majority of fishing activity at the boundary between the Irish and Celtic Sea is towards the southwest. This is illustrated by Irish VMS linked to logbook data (Figure 5.11). Most of the stocks caught in this area are likely to be part of the Celtic Sea stocks rather than the Irish Sea. In recent years, for example, cod landings reported from the ICES rectangles immediately north of the Irish Sea-Celtic Sea boundary have been re-allocated into the Celtic Sea as they represent a combination of inaccurate area reporting and catches of cod considered to be part of the Celtic Sea stock. Including the two most south-westerly rectangles of Division VIIa into VIIg is likely to solve the majority of misreporting in terms of area and stocks. This change will improve the delineation of the management areas. Other than these small changes, stocks and fisheries operating in the Irish Sea could be managed effectively within an area based management plan for the Irish Sea under current management area boundaries.

6.6 Boundary between Celtic Sea and Bay of Biscay

The EWG was unable to provide a description of the issues for this boundary and consideration of the issues should be carried forward to the EWG that discusses the Bay of Biscay and more southerly stocks.

6.7 Widely distributed stocks.

The stocks considered widely distributed on the areas being dealt with on this EWG are Hake, Herring, Horse Mackerel, Blue Whiting and Mackerel. By definition some or all of these stocks will cross boundaries between management areas.

With regards to blue whiting and mackerel separate management doesn't seem to be a major problem as the fleets targeting these stocks are not interacting with the fleets involved in the demersal fisheries nor subject cod plans in the NS, WoS, IS, CS, KT and Baltic. Some consideration may need to be given to any industrial fisheries for blue whiting in the Northern North Sea.

In the case of the northern hake stock there are direct interactions with the cod plans. Parts of the fleets involved on cod fisheries are also catching hake as well as anglerfish and megrims. In the case of horse mackerel these are caught predominantly by pelagic fisheries in the areas considered in this report, but also by demersal fisheries catching hake and angler in the areas to the south. For such cases it will be necessary to identify which fleets will be operating under restrictions of both plans, and work out the impact it may have on the successful implementation of the plans. In particular the common problem of inconsistency between quotas of species in mixed fisheries will require attention to avoid promoting discards.

Another challenging problem, if area based plans are to be implemented, will be the partition of quotas of the widely distributed stocks between areas and fleets while maintaining the restrictions of relative stability.

6.7.1 Fishery Considerations for herring

In the case of herring stocks, the fisheries are mostly regional, carried out within the areas under consideration, NS, Baltic, WoS, IS, CS.

Western Baltic herring is caught in mixed herring (and sprat) fisheries in Baltic, Kattegat, Skagerrak and North Sea along with North Sea herring. It is currently managed as part of the Baltic but with TAC rules linked with North Sea herring; see section 6.3

North Sea herring is caught in North Sea and Eastern Channel, predominantly in directed fisheries by pelagic vessels; see section 6.2

WoS herring is caught in VIa north in directed fisheries by pelagic vessels; see section 6.2

Irish Sea herring is caught in directed fisheries by pelagic vessels; see Section 6.4

Via south herring is caught by polyvalent vessels that also fish for demersal species; see Section 6.2

Celtic Sea herring is caught by polyvalent vessels that also fish for demersal species; see Section 6.2

6.7.2 Conclusion to options.

Blue whiting, mackerel and horse mackerel could be considered together as there is considerable overlap in fleets; they can be managed by separate TACs.

NS and WoS herring can either be managed by separate TACs under area plans or considered in a group with mackerel and blue whiting. The latter option takes account of the fact that the same fleets fish all these stocks.

IS herring can be managed by area or with other pelagic stocks. There is little to choose between options; see Section 6.4.

WBSS herring can be managed either with Baltic or North Sea. There is little to choose between options; See section 6.3

Celtic Sea and Via south herring can be managed by separate TAC but are probably best considered as part of the associate area plans as the fleets are linked to these areas; see Section 6.2

7 BIO-ECONOMIC MODELLING

7.1 BACKGROUND

The objective of this chapter is to describe the state of the art in bio-economic models that could be used to carry out impact assessments of management plans to be developed for the different management regions described in this report. The outline of future management plans is currently unknown, but we could expect these plans to use output management (through TACs or ITQs, limiting landings or catches), input management (by means of fishing effort or capacity limits), or spatial differentiation of marine resource use.

The potential benefit of bio-economic models is that they can give a comprehensive indication of the feedback effects between human activity and natural resource dynamics (Prellezo et al. 2012). Bio-economic models can be classified into two categories: simulation or optimisation. Simulation models strive to simulate a system

by projecting a set of biological and economic variables or parameters into scenarios to evaluate alternative management strategies, or modelling the impact of exogenous variables. This type of model is the likely candidate for impact assessments. Optimisation models aim to find optimal solutions to objective functions (e.g. revenue, profit, harvest, days at sea, ecosystem impacts) under economic and biological constraints.

The complexity of bio-economic models used for impact assessments of plans depends on the envisaged plan, and importantly, the data available to parameterize and validate the model. The models in use and the models under development all have different levels of complexity on different aspects of the fishery system. The choice for one of the models to be used for an impact assessment thus depends on the key characteristics of the fishery that needs to be dealt with.

7.2 MANAGEMENT STRATEGY EVALUATIONS

Whereas the EC must develop Multi-annual Plans (MAPs) in the context of the requirements of the Impact Assessment Board and the general objectives of the CFP, currently European legislation does not lay out any specific standards or methodology that is to be applied in the development of fisheries management plans. This contrasts with some other jurisdictions such as US, South Africa or Australia, where the fisheries management criteria are more clearly defined in the legislation. This lack of clarity has led to a diversity of approaches in Europe with methodologies similar to both Management Strategy Evaluation (MSE) and The Management Procedure Approach applied by STECF and ICES depending on the situation. The complexity of the Impact Assessments and the range of uncertainty included have varied depending on the available resources, rather than any specific standard. This has been a pragmatic approach but it has resulted in differences between MAPs for stocks and areas that are hard to justify. There is a need for a strategic discussion regarding the standards and approaches that should be applied. These decisions do not lie within the remit of science/advice alone but should involve managers and stakeholders too. The following discussion is included to highlight some of the options and implications.

The use of bio-economic models in impact assessments may have to be done in the Management Strategy Evaluation (MSE) context. In May 2012 at the World Fisheries Congress (WFC) a session was dedicated to world-wide developments in the field of MSE. Several authors had criticized the use of MSE, e.g. if the relevant uncertainty had not been sufficiently incorporated, and had proposed to incorporate qualitative modelling and/or expert knowledge from extended peer groups into the evaluation of management strategies (Rochet & Rice, 2009; Kraak et al. 2010, but see Butterworth et al. 2010). In addition, some confusion had arisen in the promotion of MSE because different groups implementing "MSE" have different interpretations of the term, despite the glossary defining concepts in Rademeyer et al. (2007). Is it a strategic or a tactical management tool? Is it intended to offer broad insights, or rather to provide specific annual management recommendations for, say, the catch limit for a stock? How does it relate to the "Management Procedure Approach" as originally developed in the Scientific Committee of the International Whaling Commission? The MP Approach was developed specifically as a tactical management tool, encompassing simulation testing of feedback-control algorithms as a necessary and structured basis for dealing with the inevitable uncertainties

associated with fisheries assessments (Butterworth 2007). Crucially, the MP Approach requires management objectives to be stated clearly from the start, and the design and evaluation of any plans developed under this framework are driven by these objectives, and include a strong stake-holder involvement. The current STECF approach to Impact Assessment is most closely allied to the MP approach. It forms part of the EC's Impact Assessment approach to all legislation which has formal requirements for stakeholder involvement. The STECF Evaluation and Impact Assessment process forms a part of the preparation of a submission to the Impact Assessment Board and is explicitly implemented with stakeholders as observers. Stakeholders are included at this stage to make the system more effective and responsive, but the formal input from stakeholders comes at a later stage in the formal EC Impact Assessment process.

At the conference, scientists from e.g. South Africa, Australia, and Europe had an open discussion in which they shared the state of the art of their best practice. It appeared that Australian scientists have experience with MSEs and/or Evaluations of Management Strategies that incorporate extensive knowledge of stakeholders (e.g. Dichmont et al.; Plaganyi et al., see WFC book of abstracts respectively PSA4.21 and PSA4.02). South African examples (small pelagics, hake) provide some of the earliest applications of the MP Approach, and management plans developed under this approach have matured to the extent that recommendations flowing from these plans are routinely followed by managers (de Moor et al. 2011, Rademeyer et al. 2008). Following this session, ICES decided to add a new Term of Reference (ToR) for the ICES WGMARS (WG Maritime Systems) on "the path towards MSEs in Europe". These ToRs were: (i) how are MSEs and MPs done in the EU and how does this differ from their original definitions originating from the IWC and practiced in South Africa and Australia and New Zealand? (ii) what would MSEs and MPs look like if implemented in Europe? What would have to change and what would be the costs and benefits? (iii) using North Sea herring as an example, WGMARS will outline a brief cost/benefit analysis of a MSE/MP process compared to the current HCR/long-term management plan process. WGMARS will not officially deliver on these ToRs until 2013, but started outlining the work the interdisciplinary team can do for these ToRs at their meeting in Kiel, Germany, 12-14 June 2012 (i.e. MSEs in relation to governance, communication of uncertainty, stakeholder participation, etc.).

It is recognised that the EC must operate within its own legislative framework and conform to the protocols that come from the Impact Assessment Board. In this context it is recommended that these purely scientific initiatives are linked together and extended to involve Commission officials so the EU benefits from world-wide lessons learned and best practices whilst developing the new-style fisheries management plans towards practices that will be successful and robust in the long-run.

7.3 BIO-ECONOMIC MODELS IN EXISTENCE AND UNDER DEVELOPMENT

An overview of a substantial number of existing bio-economic simulation models is given in Prellezo et al. (2012). Below in table 7.1, we present this list, but the models that have been replaced by more modern versions are removed. In addition this list is amended with bio-economic models currently under development under different framework research projects.

Table 7.1 Existing bio-economic models listed in Prellezo et al (2012) modified to include updated versions

ACRONYM	Short name	Management type	Area
SAHF	Dynamic capacity change model	Input/output	Atlantic
several BIRDMOD	Bio-economic model of population analysis of demersals	Input	Atlantic
several BEMMFISH	Bio-economic modelling of Mediterranean fisheries	Input	Med
several COBAS	Bio-economic model of South-west fisheries	Input	Atlantic
other EcoCoRP	Economic effects of the cod recovery plan on the mixed fisheries in the North Sea	Input/Output	Atlantic
other ECONMULT	Bio-economic multispecies model of the Barents Sea fisheries	Input/Output	Atlantic
several EMMFID	Economic management model of fisheries in Denmark	Input/Output	Atlantic
several FLR	Fisheries library in R	Input/Output	Atlantic+ Med
several MEFISTO	Mediterranean Fisheries simulation tool	Input/Output	Med
several SRRMCF	Swedish resource rent model for commercial fishery	Input/Output	Atlantic

other models not listed in the Prellezo et al. (2012) paper have been developed in the last 2 years. In addition, there are a number of bio-economic models currently under development, e.g. in Framework programs MYFISH and VECTORS. Most of these models will be finished in 2 to 3 years. These models are listed in 7.2. This table lists the model name, model description, development timeframe, and area of application.

Much research effort on these models is being put in the adaptive response of fishing fleets to fisheries management, as this is perceived to be a key issue in the understanding of the fisheries system (Fulton et al. 2011, Poos et al. 2010). Currently, this adaptive response is generally omitted from management strategy evaluations of management plans.

Table 7.2 bio-economic models recently developed or under development.

NAME	Description	Development timeframe	Area
ATLANTIS	Three-dimensional ecosystem model, linked polygons that represent major geographical features. Information is added on local oceanography, chemistry and biology such as currents, nutrients, plankton, invertebrates and fish. The model is then set in motion, simulating ecological processes such as consumption and production, waste production, migration, predation, habitat dependency, and mortality.	Several EU Framework programs are developing ATLANTIS models. Expected to be finished within the next 3 years	North Sea, Eastern Channel
ECOPATH-FISHRENT	Ecopath creates a static mass-balanced snapshot of the resources in an ecosystem and their interactions, represented by trophically linked biomass 'pools'. The biomass pools consist of a single species, or species groups representing ecological guilds. This model combines ECOPATH with FISHRENT (see below)	'MYFISH' project. This is expected to be finished within the next 3 years	Southern North Sea
F-CUBE	F-CUBE (Ulrich et al. 2011) estimates the potential future levels of effort by fleet corresponding to the fishing opportunities (TACs by stock and effort allocations by fleet) available to that fleet, based on effort distribution across its métiers, and the catchability of each of these métiers. This level of effort is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.	Models have been finished and used for advice. Development is ongoing for new management objectives	North Sea and area west of Scotland
FISHRENT	FISHRENT (Salz et al. 2011) estimates resource rents under different conditions and management regimes. It integrates simulation and optimisation, integrates output- and input-driven approaches, so that it can be consistently applied to different situations in the EU, particularly the Atlantic and the Mediterranean/Black Sea areas. To this end, it accommodates multi-species/ multi-fleet fisheries. The recent developments integrate spatial and seasonal dimensions of fisheries and age structured population dynamics.	Original model developed under the EU project 'Remuneration of spawning stock biomass'. Further development done in 'VECTORS' project	North Sea
FLR/FLBEIA	FLBEIA is abio-economic model embedded in FLR (Kell et al. 2007) that merges the main ideas of Fishrent and Fcube. As such, it is a toolbox for bio-economic impact assessments with MSE. It's multi-fleet, multi-stock, and seasonal.	Model is being developed as a collaboration between JRC and AZTI	
IAM	IAM is a bio-economic model used for the impact assessment for sole in the Bay of Biscay. It was developed in the framework of the Bio-economic partnership working group project funded by the French Ministry of Agriculture and Fisheries.	Model was used for impact assessment for sole in the Bay of Biscay	Bay of Biscay
ISIS-FISH	ISIS-fish (Mahevas and Pelletier, 2004) is a generic and spatially explicit simulation tool for evaluating the impact of management measures on fisheries dynamics. Both management measures	Model has been developed and applied in several research	Bay of Biscay, North Western

	and behaviour of fishermen in reaction to these measures may be interactively designed through a Script language	projects.	Mediterranean
NWWRAC - DST	Stochastic Decision Support Tool (DST) to assess stock and economic impacts of options for changes in gear and fleet selectivity to support the NWWRAC initiative to develop a mixed fisheries management plan for the Celtic Sea. Deterministic gear selectivity model already available	Initiative proposed by NWWRAC to support CS MP. Requires resource allocation (18 month development time)	NWWRAC Celtic Sea

7.4 BIO-ECONOMIC MODEL DEVELOPMENT FOR IMPACT ASSESSMENTS

It is clear that many initiatives for bio-economic modelling exist or are within 2 years of finishing. Most of these will produce models that can be used in a Management Strategy Evaluation when needed in an impact assessment. Several models have already been used in an impact assessment (e.g. IAM, FISHRENT). However, when new management plans are being formulated, the model set-up and parameterization will still need to be tailored for the specific questions related to the proposed management (see also Prellezo 2012). This could easily take several man-months. If a full bio-economic impact assessment is to be done for such management plans, research funding in the form of EU tender projects would allow this research effort to be undertaken. Currently for a few simple cases *adhoc* economic modelling solutions may be possible but models covering the areas suggested in the TOR are likely to be available in 2-3 years time.

7.5 BIO-ECONOMIC DATA

For bioeconomic modelling purposes it is essential to merge the information used for economic and biological analysis through the transversal variables. At the present time two such datasets exist both are supervised by JRC: the Annual Economic Report database and the Effort Management database. The biggest impediment to merging the two datasets seems to be the different definitions of fishing effort and different segmentation/aggregation levels (table 7.3). The economic data is aggregated by vessel group (pooled by country, vessel size and main gear) while the effort data is aggregated at the activity level (pooled by country, vessel size, gear, mesh size and area).

Having some consistent level of aggregation between economic, catch and effort data is critical to the bio-economic modelling of the impacts of management measures. For example, whereas effort and catch data are defined by area, the economic data cannot easily be linked to areas. This means that the economic importance of an area for a particular fishery is poorly described. On the other side it can be complicated to link the economic performances of a vessel group to the species and areas fished. Currently, linking fleets (vessel groups) to activities can be done when the fleet uses one main gear, if the fleet is polyvalent, it is very complicated to reconcile the fleet economics with its activity and may not be possible under the current data collection methodology.

For the Baltic sea it should be possible to link the annual economic and the effort databases as the effort Management database includes segmentation of the fleets for vessels <8m, >8<10m, >10<12m, >12<18m, >18<24, >24<40m and >40m. For all the other areas the linkage of the two databases are not obvious as the Annual Economic database consists of segmentation of the fleets for vessels <10m, >10<12m, >12<24m, >24<40m and >40m and the effort database consists of segmentation of fleets for vessel lengths <10m, >10<15m and >15m.

In the long term, efforts should be made to homogenize the levels of aggregation of the economic and effort database. Possible changes to the current database include changes to the fleet definition in the AER database by adding a spatial dimension depending on the area on which the fleet depends the most (in the same way as the main gear is defined), the EM database should also have vessel sizes consistent with the one used in the AER (as in the Baltic). Work has been done in the ICES WGMIXFISH to try and use fleets with vessel sizes consistent with the economic data (table 7.3). Such a database could be extended to areas outside the North Sea and data made available to an STECF WG.

In the short term, progress might be made by developing links between the databases possibly by modelling the relation between transversal variables and trying to get around the aggregation limitations using statistical methods. Such an exercise has not been attempted so far but, as it seems to be the only option currently available to link economic and biological variables, it may prove to be worthwhile exploring.

Table 7.3 Description of the Annual Economic report, Effort Management and MIXFISH databases

Database	Fleet definition	Length classes:	Gear:	Data available	Time series
Annual Economic Report database	Fleet defined as country, vessel size and MAIN gear (one vessel can only be in one group per year)	Mediterranean Sea and Black Sea: 0-6m, 6-12m, 12-18m,18-24m, 24-40m,>40m Other areas: 0-10m, 10-12m, 12-18, 18-24m, 24-40m, >40m	Main gear used in the year (in terms of fishing effort)	Costs, investment, capacity, employment, income, effort	
Effort Management	Fleet as country, vessel size and gear (one vessel can be in several group per year)	Baltic Sea:0-8, 8-10, 10-12, 12-18, 18-24, 24-40, >40 Other: 0-10m, 10-15m, >15m	Gear used + mesh size	Effort (days, fishing days, GT, kw), landings per rectangle, discards	Since 2003
WGMIXFISH database (linked to single species advice)	Fleet as country, vessel size and gear	0-10m, 10-24m, 24-40m, >40m	Gear used + meshsize (métiers DCF)	Effort, landings, discards for North Sea stocks, métiers and fleets	Since 2003

8 TIMETABLE DEVELOPMENT OF ADVICE ON PLANS

This section details the stocks by current European Commission proposed areas assuming that Eastern Channel is combined with the North Sea. ICES has already provided a preliminary timetable for advice by ICES Eco-region, in 2011, (Table 8.1) though this is currently under revision. The EWG has tabulated a list of the stocks with single species models suitable for stochastic projection, species included in mixed fish models, and those included in multispecies models. In the multispecies models it should be noted that in some cases Ecopath/Ecosym models have been developed. Currently these complex models with very large numbers of estimated parameters may be able to give a plausible representation of aspects of the past, but they are unlikely to have predictive power to give meaningful Impact Assessments.

Table 8.1 ICES Overview of timelines for provision of integrated advice by eco-region.

Advice Type	Norwegian Sea	Barents Sea	North Sea	Baltic Sea	Wide: Pelagic	Wide: Deepsea	Biscay Iberia	Celtic Eco Region	Iceland Faroe
Single Species MSY	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	n.a.	Ongoing	Ongoing	Ongoing
Data poor MSY proxy	*2012+	*2012+	2012-2015	2011-2015	Ongoing (sharks)*	*2014+	2013-2015	2011-2015	2011-2016
Mixed fishery	n.a.	n.a.	*2012	n.a.	n.a.	n.p.	2012-2015	2013-2015	ongoing (Faroe) n.p. (Iceland)
Multi species	*2013-2016+	ongoing (cod/capelin) 2013+ (others)	*2012-2014	*2012	*2011-2016+	n.p.	*2013-2016+	*2012-2017+	Ongoing
Wider ecosystem	2013-2016+	2013-2016	2013-2016+	2012+	2011-2016+	2012+	2013-2016+	2013+	2011+
MSFD	n.a.	n.a.	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	n.a.
MSP	2013-2016+	2013-2016+	2013-2016+	2013-2016+	2013-2016+	Ongoing*	2013-2016	2012+	n.a.

n.p. not planned n.a. not applicable + advice on ongoing basis from that year * annotation in *italics* below

8.1 STOCKS MODELLED IN NORTH SEA, SKAGERRAK, KATTEGAT AND EASTERN CHANNEL

Area	Stocks Assessed	Stocks Not Assessed	Stocks with Simple bio models applied	Mix Fish	Multi species models	Spatial Assessment (without Forward projection)
North Sea (IIIa, IV and VIId)	Cod NS Haddock NS Whiting NS Herring NS Megrim IVaVIa *Nephrops* NS *Nephrops*IIIa Norway Pout NS Plaice NS PandalusIIIa SaitheIIIa IV VI Sandeel NS Sole EEC Sole NS 1.1.1. Sole IIIa Sprat Kat Whiting NS (Northern hake)	1.1.2. Brill NS Cod Kat Dab NS Dem Elasmobranch NS Flounder Horse Mackerel NS Lemon sole Ling Pandalus NS Plaice Skaggerak Plaice EEC Pollack NS Sprat Kat Turbot NS Tusk Whiting IIIa Grey Gurnard NS Angler IIaIIIa IV VI Witch NS Red mullet Cuttlefish Squid Scallops	Herring NS Cod NS Haddock NS Whiting NS Sole NS Plaice NS 1.1.3. Saithe IIIa IV VI Sandeel NS Megrim Iva VIa	Cod NS Haddock NS Whiting NS 1.1.4. Sole NS Plaice NS SaitheIIIa IV VI *Nephrops* NS Plaice EEC Sole EEC	Herring NS Cod NS Haddock NS Whiting NS Sole NS Plaice NS SaitheIIIa IV VI Sandeel NS Norway Pout NS Horse Mackerel NS Grey Gurnard NS Harbour Porpoise Grey seals	Cod Kat
				To be added in August	Not Forward projections	

Development of single species forward models rest of the assessed species - 6 person months work. If there is a requirement to add other important species this might be considered by fishery

- Beam trawl add: turbot, brill, lemon sole, dab selection modelling
- Otter trawl white fish add: Angler, lemon sole, witch, skates, rays (hake?) selection modelling
- Otter trawl *Nephrops* add: *Nephrops* (by FU) Angler, lemon sole, witch selection modelling

Development of the mixed fishery model implying a move to stochastic modelling would take a few man months for the species listed above (see below) but currently resources to do this have not been allocated.

Future development of Multi-species model to include additional species and a need for diet data (New DCF for collection).

Ecosystem Model indicative for frameworks but not for detailed fishery modelling now or in the near future.

8.2 STOCKS MODELLED IN WEST OF SCOTLAND AND ROCKALL

Stocks with agreed assessments	Stocks without agreed assessments	Forecast models used	Mixed fisheries stocks	Multi-species models
Cod VIa Haddock VIa Haddock VIb Whiting VIa Herring VIaN Herring VIaS *Nephrops* (3 FUs) SaitheVIa Megrim IVa VIa Spurdog Hake VIa	Cod VIb Whiting VIb Grey gurnard VIb 1.1.5. Ling VIb Tusk VIb Clyde herring Angler VIa + VIb* Elasmobranchs Seals + other cetaceans Squid Sandeel Sprat Norway pout Crustaceans and molluscs**	1.1.6. Cod VIa Haddock VIa Haddock VIb Herring VIaN Herring VIaS Saithe Via Megrim IVa VIa	WGMIXFISH planned for August 2012	StrathBIOM Cod-seal model Ecopath

*Assessment may be agreed soon.

**Assessments conducted within Scotland.

There is a shortage of resources to develop models. This area is not covered under projects such as MYFISH. Currently developments are expected to be slow unless priorities are changes and resources specifically allocated.

There is a development of a decision support tool for mixed fisheries plans which would probably be applicable for this area. It would need resources to parameterise this with local data.

8.3 STOCKS MODELLED IN IRISH SEA

Area	Stocks Assessed	Stocks Not Assessed	Stocks with Simple bio models applied	Mix Fish	Multi species models	Spatial Assessment (without Forward

						projection)
Irish Sea	Cod IS Herring VIIaN *Nephrops* IS Plaice IS Sole IS	Anglerfish Crustaceans* Elasmobranchs Haddock IS# Queen Scallops** Sprat Scallops* Whiting IS	None	None	Ecopath	None

* Assessments done within national labs under inshore management

** Assessments already done for some areas within national labs under inshore management

Survey based assessment with no forecast

There are only a small number of stocks highlighted without single species assessment and without forward projections. The haddock stock is scheduled for ICES benchmark in 2013. No assessment currently exists for all other species other than whiting and would require a significant amount of data collation and model development.

There are no existing mixed fisheries or multispecies models for the Irish Sea, other than an Ecopath model, but this does not have forecast capabilities. A number of initiatives and proposals are currently under development, e.g., development of a mixed fisheries management plan for the Irish Sea developed through NWWRAC, initiatives within Northern Ireland to look at different aspects of an ecosystem model. These initiatives will no doubt be complementary to this process, but it does not replace the requirement for developing mixed fishery models to perform impact assessment to enable the evaluation of any proposed management plan. Ecosystem models describe the current system and interactions, but are unlikely to lead to reliable forecasts.

The following fisheries models need to be developed for the main fisheries, including selection models:

- Beam trawl: The currently low catch advice for sole effort in this fishery is expected to decline significantly. Bycatches of brill, turbot and lemon sole are also taken in this fishery. There are no catch regulations for these species, the stock identifies are uncertain and abundances have always been low within the Irish Sea.
- Otter trawl (*Nephrops* directed, TR2): This is the main fishery within the area and catches are dominated by *Nephrops*. Bycatch of fish species listed in the table above including brill, turbot and lemon sole, are taken but at relatively low tonnage.

There is also small whitefish fleet (TR1), consisting of four vessels, which declined in relation to cod management measures. The pelagic fleet targeting herring is also small and the fleet will probably be best managed through a long-term management plan for herring. A significant scallop fishery now exists in the Irish Sea, but has very little bycatch of other species.

There is a shortage of resources to conduct the stock assessments, mixed fishery and multi-species work. Developments are expected to be slow unless priorities are changed and resources specifically allocated.

8.4 STOCKS MODELLED IN WESTERN CHANNEL

Area	Stocks Assessed	Stocks Not Assessed	Stocks with Simple bio models applied	Mix Fish	Multi species models	Spatial Assessment (without Forward projection)
Western Channel (VIIe)	Sole WC Plaice WC Cod VIIe-k Haddock VIIb-k Whiting VIIe-k	Seabass Red mullet Cuttlefish Squid Scallops	Sole WC Plaice WC Cod VIIe-k Haddock VIIb-k Whiting VIIe-k	None	None	None

8.5 STOCKS MODELLED IN CELTIC SEA

Area	Stocks Assessed	Stocks Not Assessed	Stocks with Simple bio models applied	Mix Fish	Multi species models	Spatial Assessment (without Forward projection)
Celtic Seas (VIIb-k)	Cod VIIe-k Haddock VIIb-k Whiting VIIe-k Sole VIIfg Sole VIIe *Nephrops* FU22 *Nephrops* FU16 *Nephrops* FU17 Herring VIIaSVIIg,h,j,k Northern hake Albacore tuna Bluefin tuna Blue whiting NE Mackerel Western Horse mackerel	Pollock VII Saithe VII, VIII, IX, X Dab NS Plaice VIIbc Plaice VIIfg Plaice VIIhjk Sole VIIbc Sole VIIhjk Anglerfish VII & VIII Megrim VIIb-k & VIIIabe Skates and Rays VI & VII Seabass Boarfish Sprat VI, VIIa-c and f-k Grey Gurnard VI &VIIa-c and e-k Sprat VIIe,d	None	None	Ecopath	

Increasing number of key gadoid species (cod, haddock and whiting) now with full analytical assessments with forecasts, but assessment for anglerfish, megrim, sole and plaice is lacking. These require further benchmarking. These are key species in the wider Celtic Seas and methodologies are required to incorporate these into any mixed-fisheries model.

There is a general paucity in the availability of predation data to under pin mixed species modelling, to progress this approach stomach content data collection and analysis is required.

A deterministic gear selectivity model quantifying impacts on catches associated with changes in cod-end selectivity is currently available and has been used to support a recent NWWRAC initiative to increase selectivity in the Celtic Sea demersal trawl fisheries. There is a

NWWRAC initiative to develop this further to include stochastic stock and economic responses and impacts associated with gear modifications and fleet behaviour. This proposal also includes a dedicated economic data collection programme at a metier level. The overall objective is to develop a stochastic decision support tool providing an information basis for stakeholders to understand the potential impacts for different mixed fisheries management options. The proposed modelling framework is intended to be sufficiently flexible for use in other management areas. This work would take approximately 18 months to complete. Structured selectivity experiments are intended to operate in parallel providing further selectivity data on other gear options and will be incorporated into the selectivity model.

There are a number of on-going fisheries ecosystem projects under the Irish Beaufort EAFM programme and linked to FP7 projects such as MYFISH on MSY variants. These have advanced fisheries science in the Celtic Seas considerably over the past few years. These studies include marine mammal interactions with fisheries, in terms of resource competition, depredation and bycatch effects. Modelling work includes Ecopath with Ecosim models, initially developed at CEFAS, and size spectra modelling. Other work is ongoing on fishing effects on fish community indicators e.g. LFI, MTL and other food web and biodiversity indicators, as well as fine scale fleet, stock and habitat interactions. These analyses and assessments are linked to the development work for MSFD fisheries indicators. The Size spectra modelling work is up and running and can be used to evaluate management options, although it is not based on empirical species data, but rather on ecological principles. The EwE models are well developed and could be made operational in a reasonably short time scale e.g. one year. Fish community, food web, and biodiversity indicators have already been developed and could be provided in the short term. Detailed information on marine mammal interactions is underway, and results should be available within one to two years. Habitat interactions will be the subject of the FP7 Project BENTHIS, currently under negotiation, and expected to last four to five years.

8.6 SUMMARY OF MODELLING TIMETABLE

8.6.1 COMBINED SINGLE SPECIES MODELS

For all areas there are some individual species models available that could be combined to give biological impact assessments for different exploitation regimes.

These may need to be extended to include a greater number of species, this is likely to be of the order of 6 man months for the assessed stocks for each area. The resources required will increase as the number and complexity of management regimes increases. Clear objectives established at a scoping meeting would help. Given the current availability of suitable manpower resources it is likely that the work in one area may impact progress in adjacent areas.

If there is a need to develop models for stocks without assessments to bring them into the impact assessment models then additional work will be required. It would be helpful for the Commission to define a list of stocks by region that need to be modelled.

8.6.2 MIXED FISHERIES ELEMENTS

Development of mixed fishery models will be very different for different areas. For the North Sea mixed fishery advice is now available, but stochastic projection required to give impact

assessments is not yet available. This is not a major issue to set up but currently resources have not been allocated to do this. Once the software changes are made, potentially this development will be usable for all areas. Mixed fisheries advice for west of Scotland should be available from August this year, but forward models will depend on the same stochastic modelling possibilities as for the North Sea. Development for other areas is expected to be much slower, depending on assembly of fleet data.

In the case of the Baltic, multi-species advice is available and preliminary multispecies models are in use for the development of impact assessments (see STECF EWG 12-02). For the North Sea similar models exist for short term advice but need more development to be used for Impact Assessments. However for both these models to deliver good multispecies advice up to date diet analyses are required, though some additional data will be available from an EU contract currently under preparation. The proposed changes to the DCF envisage the collection of diet data for all areas in the future. In the Celtic Sea, Biscay and Iberian regions, timelines will be longer. For the Celtic sea stomach data do not exist. Additional research is needed to compliment work already underway. Given the shortage of recent diet data in the Baltic, STECF considered that continuation using single species MSY values was appropriate along with the collection of new diet data. The primary issue was that the data sparsity required single area models but spatial distributions are known to have changed considerably. Given the situation in the NS which is similar it may be that STECF would give similar advice. Collection of diet data now would speed up the development of these models.

8.6.3 DEVELOPMENT OF SPATIAL MODELS

Currently very few useful spatial models that can be used to explore spatial management options exist. Seasonal data on landings by species by rectangle can give some information on the use of spatial models to evaluate the potential for managing mixed fisheries through spatial models, in a limited number of simple cases such as NS sole and plaice and *Nephrops* Fisheries there is some scope for spatial management based on existing data. Data on fish movement is limited so fully spatial models will be difficult to develop in the medium term.

9 PROVISION OF ADVICE ON CHANGES IN MSFD DESCRIPTORS FOR DIFFERENT OPTIONS IN MANAGEMENT PLANS

ACOMMISSION DECISION, 1 September 2010, on criteria and methodological standards on good environmental status of marine waters (2010/477/EU), MSFD gives the following definitions for descriptors 3, 4 and 6 noted on the ToR.

Descriptor 3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

3.1. Level of pressure of the fishing activity — Fishing mortality (F) (3.1.1).

Achieving or maintaining good environmental status requires that F values are equal to or lower than F MSY , the level capable of producing Maximum Sustainable Yield (MSY).

3.2. Reproductive capacity of the stock — Spawning Stock Biomass (SSB) (3.2.1).

3.3. Population age and size distribution

— Proportion of fish larger than the mean size of first sexual maturation (3.3.1)

— Mean maximum length across all species found in research vessel surveys (3.3.2)

— 95 % percentile of the fish length distribution observed in research vessel surveys (3.3.3).

Modelling descriptor 3 is expected to be possible for the populations that can be parameterised in any of the management plan evaluations, descriptors 3.1 and 3.2 are already available in most biological models, minor modifications to models may be required to generate values for the three descriptors 3.3 and these will be limited to stocks that are parameterised in the models. It is anticipated that information on potential changes in descriptor 3 will be relatively easy to provide.

Descriptor 4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

4.1. Productivity (production per unit biomass) of key species or trophic groups

— Performance of key predator species using their production per unit biomass (productivity) (4.1.1).

4.2. Proportion of selected species at the top of food webs

— Large fish (by weight) (4.2.1).

4.3. Abundance/distribution of key trophic groups/species

— Abundance trends of functionally important selected groups/species (4.3.1).

— groups with fast turnover rates (e.g. phytoplankton, zooplankton, jellyfish, bivalve molluscs, short-living pelagic fish) that will respond quickly to ecosystem change and are useful as early warning indicators,

— groups/species that are targeted by human activities or that are indirectly affected by them (in particular, by-catch and discards),

— habitat-defining groups/species,

— groups/species at the top of the food web,

— long-distanceanadromous and catadromous migrating species,

— groups/species that are tightly linked to specific groups/species at another trophic level.

Modelling of descriptor 4.1 does not fit directly with the kind of models that are used for impact assessments for fisheries. Modelling descriptor 4.2 is expected to be possible for the populations that can be parameterised in any of the management plan evaluations. It is currently unclear what is implied by descriptor 4.3, some groups will be available from fisheries models, some will require different ecosystem models (See EWG 10-03 for ecosystem models and EWG 11-14 for a discussion of MSFD descriptor 4)

Descriptor 6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

6.1. Physical damage, having regard to substrate characteristics

— Type, abundance, biomass and areal extent of relevant biogenic substrate (6.1.1)

— Extent of the seabed significantly affected by human activities for the different substrate types (6.1.2).

6.2. Condition of benthic community

— Presence of particularly sensitive and/or tolerant species (6.2.1)

— Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species (6.2.2)

— Proportion of biomass or number of individuals in the macrobenthos above some specified length/size (6.2.3)

— Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community (6.2.4).

Modelling descriptor 6 Models available for impact assessments of fisheries are rather limited in the context of descriptor 6. It may be possible to include some indications of fishing effort by gear type within some of the modelling frameworks. Appropriate bottom impact models exist (e.g. IMPACT projectKaiser and de Groot S.J. (eds) 2000Lindeboom, H.J. & de Groot, S.J. 1998.)for the range of fishing gears to be considered, an index of bottom impact may be achievable to give quantitative index for 6.1. and 6.2 However, these will require some information on habitat types for each fishery, implying spatial models that current are not available for impact assessments of fisheries and it is difficult at this stage to determine if sufficient data is available for such modelling. Qualitative discussion of different management options based on different scenarios should be possible for all areas.

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11 EWG-12-07 LIST OF PARTICIPANTS

Name	Address	Telephone no.	Email
STECF members			
Clara Ulrich Rescan	DTU-Aqua Charlottenlund Castle 2920 Charlottenlund Denmark	Tel: 0045 33963395 Fax: 0045 33963333	clu@aqua.dtu.dk
Jenny Nord	Swedish Agency for Marine and Water Management Ekelundsgatan 1 404 39 Göteborg Sweden	Tel: Fax:	jenny.nord@havochvatten.se
John Simmonds (chair)	Consultant United Kingdom		e.j.simmonds1@gmail.com
Nick Bailey	Marine Scotland Science Marine Lab. Victoria Road AB11 9DB Aberdeen United Kingdom	Tel: 0044(0)1224295398 Fax:	baileyn@marlab.ac.uk
Norman Graham	Marine Institute Rinville Co Galway Ireland	Tel: +353(0)91387307 Fax: +353(0)91387201	norman.graham@marine.ie
Sarah Kraak	University College Cork Rinville Oranmore County Galway Ireland	Tel: 35391387392 Fax: 35391387201	sarah.kraak@marine.ie
Willy Vanhee	ILVO Hospitaalstraat 8400 Oostende Belgium	Tel: +32(059)433083 Fax:	wvanhee@pandora.be
Invited experts			
Alexander Kempf	Institute of Sea Fisheries vTI-SF Palmaille 9 22767 Hamburg Germany	Tel: +49 (0)40 38905194 Fax:	alexander.kempf@vti.bund.de
Jan Jaap Poos	Wageningen IMARES Haringkade 1 1976 CP IJmuiden Netherlands	Tel: 31317487189 Fax:	janjaap.poos@wur.nl
Katell Hamon	LEI part of WUR Alexanderveld 5 2585DB Den Haag Netherlands	Tel: Fax:	katell.hamon@wur.nl
Morten Vinther	DTU-Aqua Charlottenlund Castle 2920 Charlottenlund Denmark	Tel: +45 33963300 Fax: + 45 33963333	mv@aqua.dtu.dk

Name	Address	Telephone no.	Email
John Powell	University of Gloucestershire Oxstalls Lane GL2 9HW Gloucester United Kingdom	Tel: +441242714129 Fax: +441242714395	jpowell@glos.ac.uk
Jose De Oliveira	Cefas Pakefield Road NR33 0HT Lowestoft United Kingdom	Tel: +44(0)1502562244 Fax: +44(0)1502513865	jose.deoliveira@cefas.co.uk
Paul Dolder	Cefas Pakefield Road NR33 0HT Lowestoft United Kingdom	Tel: +441502524259	paul.dolder@cefas.co.uk
Sasha Maguire	Marine Scotland Victoria Quay EH6 6QQ Edinburgh United Kingdom	Tel: +441312440563	sasha.maguire@scotland.gsi.gov.uk
John Anderson	Sea Fish Industry Authority 18 Logie Mill, Logie Green Road EH7 4HS Edinburgh United Kingdom	441315248662 7776197188 Fax: 441315248696	john_anderson@seafish.co.uk J_Anderson2@seafish.co.uk
Alyne Delaney	IFM, Aalborg University North Sea Science ParkWillemoesvej 2, Postboks 104 9850 Hirtshals Denmark	+45 9940 3694 +45 21 34 3776 Fax: +45 9815 3788	ad@ifm.aau.dk alyne.delaney@yahoo.dk
Coby Needle	Marine Scotland Science Marine Lab. Victoria Road AB11 9DB Aberdeen United Kingdom	Tel: +441224876544	Coby.Needle@scotland.gsi.gov.uk
Pier-Jan Schon	Agri-Food & Biosciences Institute Newforge Lane BT9 5PX Belfast United Kingdom	+44 28 90255015 Fax: +44 28 90255004	pieter-jan.schon@afbini.gov.uk pj.schon@yahoo.com
Youen Vermard	IFREMER 150, Quai Gambetta 62200 Boulogne sur mer France		youen.vermard@ifremer.fr
JRC Experts			
Colin Millar	JRC Via Enrico Fermi 2749 21027 Ispra (VA) Italy	Tel: +390332785311 Fax: +390332789658	colin.millar@jrc.ec.europa.eu
Ernesto Jardim	JRC Via Enrico Fermi 2749 21027 Ispra (VA) Italy	Tel: +390332785311 Fax: +390332789658	ernesto.jardim@jrc.ec.europa.eu
European Commission			

Name	Address	Telephone no.	Email
Robert Griffin	European Commission 79 Rue Joseph II 1000 Brussels Belgium	Tel: +32 2295 6070	robert.griffin@ec.europa.eu
Stefanie Schmidt	European Commission 99 Rue Joseph II 1000 Brussels Belgium	Tel: +32 229 59296 Fax:+32 229 94802	stefanie.schmidt@ec.europa.eu
Stuart Reeves	European Commission 79 Rue Joseph II 1000 Brussels Belgium	Tel: +32 229 80156 Fax:	stuart.reeves@ec.europa.eu
Colin Millar	JRC STECF secretariat Via Enrico Fermi 2749 21027 Ispra (VA) Italy	Tel: +390332785311 Fax: +390332789658	stecf-secretariat@jrc.ec.europa.eu
Observers			
Geert Meun	Fishermen's Org. VisNed Vlaak 12 8321 RV Urk Netherlands	Tel: Fax:	gmeun@visned.nl
Michael Park	SWFPA 40 Broad Street ab439ah Fraserburgh United Kingdom	Tel: 1346514545 Fax:	mikeswfpa@aol.com
Greig Chalmers	Marine Scotland Victoria Quay EH6 6QQ Edinburgh United Kingdom	+44 131 244 6081 07500 883217 Fax:	greig.chalmers@scotland.gsi.gov.uk greig.chalmers@btinternet.com
Kenneth Coull	Scottish Fishermen's Federation 24 Rubislaw Terrace AB10 1XE Aberdeen United Kingdom	441224646944 447974729843 Fax: 441224647058	k.coull@sff.co.uk kacoull@gmail.com
Barrie Deas	Nat. Fed. Fishermen's Orgs 30 Monkgate YO317PF York United Kingdom	441904635430 447795293905 Fax: 441904635431	bdeas@nffo.org.uk barriedeas@sky.com
Caroline Gamblin	CNPMEM 134 avenue de Malakoff 75116 Paris France	Tel: +33172711800	cgamblin@comite-peches.fr
HenkDemkes	Ministry Econ. Affairs, Agriculture, Innovati on Bezuidenhoutseweg 73 2500 EK Den Haag Netherlands	Tel: +31703786486	h.demkes@mineleni.nl
Segolene Monteillier	DPMA-MAAPRAT 3 Place de Fontenoy 75007 Paris France	Tel: +330149558219	segolene.monteillier@agriculture.gouv.fr

Name	Address	Telephone no.	Email
Sean O'Donoghue	Killybegs Fishermen's Organisation Ltd Bruachnamara, St Catherines Road, Killybegs, co Donegal Ireland	353749731089 353874196535 Fax: 353749731577	kfo@kfo.ie olgakillybegs@gmail.com
Jacques Pichon	Les Pêcheurs de Bretagne BP 61225 29102 Quimper cédex France	33298101111 33618165894 Fax: 33298103610	jacques.pichon@pecheursdebretagne.eu op@pecheursdebretagne.eu

12 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg07

List of background documents:

1. EWG-12-07 – Doc 1 - Declarations of invited and JRC experts.

European Commission

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Title: Scientific, Technical and Economic Committee for Fisheries: Management plans part 2 - developing area based management plans (STECF-12-14).

STECF members: Casey, J., Abella, J. A., Andersen, J., Bailey, N., Bertignac, M., Cardinale, M., Curtis, H., Daskalov, G., Delaney, A., Döring, R., Garcia Rodriguez, M., Gascuel, D., Graham, N., Gustavsson, T., Jennings, S., Kenny, A., Kirkegaard, E., Kraak, S., Kuikka, S., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Nowakowski, P., Prellezo, R., Sala, A., Scarcella, G., Simmonds, J., Somarakis, S., Stransky, C., Theret, F., Ulrich, C., Vanhee, W. & Van Oostenbrugge, H.

EWG-12-07 members: Clara Ulrich Rescan, Jenny Nord, John Simmonds, Nick Bailey, Norman Graham, Sarah Kraak, Willy Vanhee, Alexander Kempf, Jan Jaap Poos, Katell Hamon, Morten Vinther, John Powell, Jose De Oliveira, Paul Dolder, Sasha Maguire, John Anderson, Alyne Delaney, Coby Needle, Pier-Jan Schon, YouenVermard, Colin Millar, Ernesto Jardim.

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Abstract

The STECF Expert Working Group (EWG 12-07) on Management plans pt2 met in Edinburgh, Scotland from 18 to 22 of June 2012. The meeting provided two reports one on management aspects relating to the revision of cod management plans (STECF-12-13) and this report which considers area and modelling options.

It is concluded that it may be preferable to join the Eastern Channel with the North Sea and join the Western Channel with Celtic Seas. It is considered preferable to join both Kattegat and Skagerrak with the North Sea largely because of the important *Nephrops* fisheries. The Northern boundary of the Irish Sea is considered to be appropriately located, a minor modification is proposed for the southern boundary to deal with catches that are taken within the current area and reallocated to Celtic Sea. Fishing activities are strongly linked economically between VIa north and IVa, and VIa south and Celtic Seas suggesting there may be potential benefits in splitting the West of Scotland area and joining the two parts accordingly. Such an approach would create a very large 'greater North Sea' with diverse fleets and there is potential to split this along a largely hydrographic boundary reducing the scale of the area and reducing fleet diversity within areas.

For each area the report outlines modelling possibilities and indicative resource implications identified for different options. Currently only small scale *adhoc* economic analysis can be provided based on the existing tools. It is anticipated it will be between 2 to 3 years to provide more comprehensive area based economic advice and this is conditional on developing ways to link the biological and economic data

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Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.