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Scientific, Technical and Economic Committee for Fisheries (STECF) Scoping for Impact Assessments for Multi-Annual plans for Baltic Multi-species and cod in the Kattegat, North Sea, West of Scotland and Irish Sea. (STECF-12-05)

Edited by John Simmonds & Ernesto Jardim

This report was reviewed by the STECF during its 39th plenary meeting
held from 16 to 20 April 2012, in Brussels, Belgium

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Scoping meeting for Impact Assessments for Multi-Annual plans for Baltic Multi-species and cod in the Kattegat, North Sea, West of Scotland and Irish Sea. (STECF-12-05)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS 16-20 APRIL 2012

Request to the STECF

STECF is requested to review the report of the **EWG-11-15** held from November 28 to December 2, 2011 in Edinburgh, evaluate the findings and make any appropriate comments and recommendations.

Introduction

The report of the Expert Working Group on Scoping meeting for Impact Assessments for Baltic Multi-species plan and cod plans in the Kattegat, North Sea, West of Scotland and Irish Sea. (STECF EWG 15-11) was reviewed by the STECF during its 39th plenary meeting held from 16 to 19 April, 2012 in Brussels, Belgium. The following observations, conclusions and recommendations represent the outcomes of that review.

STECF observation

This report forms the basis of work towards Impact Assessments which will be dealt with by STECF at later plenaries in 2012, as such it does not constitute final work that can form the basis of an STECF opinion

STECF conclusions

STECF draws no specific conclusions from this report as it describes work in progress

STECF recommendations

STECF makes no specific recommendations from this report as it describes work in progress

REPORT TO THE STECF

EXPERT WORKING GROUP ON Scoping for Impact Assessments for Multi-Annual plans for Baltic Multi-species and cod in the Kattegat, North Sea, West of Scotland and Irish Sea. (EWG-11-15)

Edinburgh Scotland November 28-December 2, 2011

1 EXECUTIVE SUMMARY

The EWG met from 28 November to 2 December in Edinburgh, for scoping the preparation of Impact Assessments for new management plans. The meeting involved observers (3 Commission staff, 14 managers and stakeholders) and 27 scientists dealing with (socio-)economics and biology and prepared for work on the following groups of stocks:

a) Impact Assessments for a new plan for cod, herring, sprat (and flounder) in the Baltic Sea.

b) Impact Assessments for new plans for cod in the Kattegat, North Sea, West of Scotland and the Irish Sea. For NS and consideration has been given to other demersal stocks. For WoS, IS and Kattegat more work is required to extend the cod advice to mixed species fisheries,

For each area (Eastern/Western Baltic, Kattegat, North Sea, West of Scotland, Irish Sea):

- The report provides information on the technical linkages between stocks in the area. For Baltic these interactions are of limited significance.
- The report provides a description of the status of understanding on biological interactions relevant for forward projection needed to give Impact Assessments.
- Only for the Eastern Baltic are the models sufficiently well developed and parameterised to account for multispecies interactions, though even for this area interactions are limited to later life stages. For NS and WoS biological interactions for cod are proposed, particularly for marine mammals. Proposals for approaches to incorporating the main linkages into multi-annual management plans are made for Baltic and NS and studies to consider MSY objectives for those plans in this context are proposed.
- Considerations are given to other objectives, relating to ecological and economic sustainability and for Baltic and NS modelling are proposed.
- Candidate management measures that could contribute to the delivery of the objectives of the plans are discussed and studies dealing with compliance and the opinions of stakeholders are proposed.
- The data, research and scientific advice needed to support the implementation of multi-stock management plans are identified,
- Major gaps in the availability of the relevant science are identified.
- Work plan for the work necessary to evaluate the potential impacts of these options are proposed.

The Impact Assessment report for multispecies plans for the Baltic should be prepared in March, provisional dates are 26-30 March 2012

The Impact Assessment report for mixed fishery plans for NS and cod in WoS, IS and Kattegat should be prepared in June, provisional dates are 16-20 June 2012

More work is needed to develop approaches to mixed fisheries in West of Scotland, Irish Sea and Kattegat. Its proposed that the needs for this work is considered at the next WG in March 2012.

2 CONCLUSIONS OF THE WORKING GROUP

The EWG provides two work program tables describing the work required. The WG concludes that these for the basis of a balance between work needed and resources available to provide an Impact Assessment for multispecies management in the Baltic and mixed species management in North Sea. More work is required to develop mixed species approaches in West of Scotland and Irish Sea and Kattegat.

3 RECOMMENDATIONS OF THE WORKING GROUP

The WG recommends that the work program detailed in section 5.6-7 and 6.6-7 be carried out.

4 INTRODUCTION

Following the evaluation of plans for stocks in Kattegat, North Sea, Irish Sea and West of Scotland (STECF EWG 11-01/07) evaluation of Baltic cod plans (SGMOS 10-06a&b) and the work on single species plans for cod in the Baltic (STECF EWG 11-01/07) it was decided to provide impact assessments for multi-annual multispecies plans for Baltic and for demersal species in the Kattegat, North Sea, Irish Sea and West of Scotland. The STECF approach to Impact Assessments follows procedures laid out in STECF SGMOS 10-01 and envisages a minimum of two meetings, a scoping meeting and a report meeting, this meeting forms the scoping meeting for both tasks.

4.1 Terms of Reference for EWG-11-15

Hold a meeting 28 November to 2 December in Edinburgh, for scoping and preparation of Impact Assessments for new management plans. The meeting should involve observers (Commission staff, managers, stakeholders) and scientists dealing with (socio-) economics and biology and should prepare for work on the following groups of stocks:

a) Impact Assessments for a new plan for cod, herring and sprat in the Baltic Sea.

b) Impact Assessments for new plans for cod and, where appropriate, other demersal stocks in the Kattegat, North Sea, West of Scotland and the Irish Sea.

For each area (Eastern/Western Baltic, Kattegat, North Sea, West of Scotland, Irish Sea):

- Describe and, where possible, quantify the biological and technical linkages between stocks in the area.
- Identify and discuss approaches to incorporating the main linkages into multi-annual management plans, and into MSY objectives for those plans.
- Consider how other objectives, relating to ecological and economic sustainability could be addressed within a management plan, and how progress towards these objectives might be evaluated.
- Identify candidate management measures that could contribute to the delivery of the objectives of the plan
- Identify the data, research and scientific advice needed to support the implementation of multi-stock management plans, according to the existing and future set-up of plans and identify major gaps in the availability of the relevant science.
- Based on the above, and taking into account STECF's existing evaluations of the long-term management plans for cod in each area:
  - o Identify a number of options for revised management plans to be taken forward into the impact assessments
  - o Provide a work plan for the work necessary to evaluate the potential impacts of these options.

4.2 Background

The reform of the CFP foresees several changes to the political framework for fisheries management that will have a direct or indirect impact on the scope and concept of long-term management plans and thus the respective needs for scientific advice.

Under the future policy a multiannual plan shall include:

(a) the scope, in terms of stocks, fishery and the marine ecosystem to which the multiannual plan shall be applied;

(b) objectives consistent with:

- the application of the precautionary approach to fisheries management ensuring exploitation that restores and maintains populations of harvested species above levels which can produce the maximum sustainable yield by 2015
- the implementation of the ecosystem-based approach to fisheries management to ensure that the impacts of fishing activities on the marine ecosystem are limited

(c) quantifiable targets expressed in terms of:

i) fishing mortality rates, and/or

ii) spawning stock biomass, and

ii) stability of catches.

(d) clear time frames to reach the quantifiable targets;

(e) technical measures including measures concerning the elimination of unwanted catches;

(f) quantifiable indicators for periodic monitoring and assessment of the progress related to achieving the targets of the multiannual plan;

(g) specific measures and objectives for the freshwater part of the life cycle of anadromous and catadromous species;

(h) measures to minimise impacts of fishing on the eco-system;

(i) safeguards and criteria activating those safeguards;

(j) any other measures suitable to achieve the objectives of multiannual plans.

Three quotes from the reform proposal are particularly relevant here:

- “The Commission proposes decentralization that may authorize Member States to adopt the conservation and technical measures necessary to achieve the objectives and targets using a toolbox of measures under the conservation policy”
- "Multi-annual plans should where possible cover multiple stocks where those stocks are jointly exploited. The multiannual plans should establish the basis for fixing fishing opportunities and quantifiable targets for the sustainable exploitation of stocks and marine ecosystems concerned, defining clear timeframes and safeguard mechanisms for unforeseen developments."
- "Measures are needed to reduce and eliminate the current high levels of unwanted catches and discards. Indeed, unwanted catches and discards constitute a substantial waste and affect negatively the sustainable exploitation of marine biological resources and marine ecosystems as well as the financial viability of fisheries. An obligation to land all catches of managed

stocks caught during fishing activities in Union waters or by Union fishing vessels should be established and gradually implemented."

In short, under a reformed CFP, management plans will be multi-stock where possible, with substantial scope for member states to implement their own management measures to achieve the objectives of the plan. It is also likely that restrictions on yields from a given stock will be specified as catches rather than landings, given the likely implementation of a discard ban. For herring a discard ban shall be in place from 01 January 2014, for cod it is anticipated from 1 January 2015.

The Commission envisages that the new plan for the Baltic stocks will be a multi-species plan which accounts for the biological interactions between the three species, particularly predator-prey interactions. Similarly, it is envisaged that the new plans in the other areas will be, where possible, mixed-fishery plans, which account for the extent to which different species are caught together by different fleets in different fisheries.

In the case of the Baltic, it is anticipated that the new plan will account for biological interaction while the plans in the other areas will address technical interactions. While the issues are different in the two cases, there is common ground in the approach needed to incorporate multiple species within a single long-term management plan. In both cases, there is a need to extend simple single-stock harvest rules to account for multiple stocks, so that the fishing opportunities for that stock are determined not only by the status of that stock, but also by the status of linked stocks, whether those linkages are biological or technical. The explicit linking of different stocks also has implications for management objectives, particularly the definition of MSY in such cases.

At present the Commission understands that the scientific basis is relatively well developed for providing advice on multi-species interactions in the Baltic and mixed-fishery interactions in the North Sea. In the other cases, where the science is less well developed, it may not be practical to implement multi-stock plans at this stage. In these cases it will nonetheless be useful to identify where significant interactions occur, and to identify significant gaps in the understanding of these interactions.

The work plans to be prepared should, *inter alia*, identify the contributions to the work that can be made by STECF and ICES, and ensure co-ordination between the two. Scientists/economists should identify existing modelling frameworks which will be used to analyse multi-species/mixed-fishery interactions.

4.3 Agenda

The following agenda was adopted at the start of the meeting.

1400 - 1730 Monday 28 November	**Open meeting**
Introduction, ToR, Reports,	John Simmonds
Preparation for IA for cod plans in KAT NS IS and WoS	
Commission overview and objectives	Stuart Reeves
Brief summary of conclusions from STECF EWG 11-07	John Simmonds
Identifying Fisheries and fleet Segments (Effort Group)	Nick Bailey, Norman Graham
Mixed fisheries advice	Clara Ulrich
Biological and technical linkages between stocks in the area. Status of Multispecies modelling and knowledge of linkages	Morten Vinther, Steve Holmes
Discussion / selection of stocks and fleets to be included	
Discussion biological objectives single species MSY / Multi-species MSY / Mixed species MSY	

0830 – 1730 Tuesday (cod plans in KAT NS IS and WoS)	
Economic / Social Objectives	Sasha Maguire
Objectives / Metrics	RACs - MSs
Control and incentives, impact of discard policy	Jenny Nord
Discard ban monitoring - experience in Norway	Irene Huse
Observers for data and for enforcement	Norman Graham
Management options (1)	Sarah Kraak
Further Management option	
Biological approaches potential metrics (by area) to determine how progress towards these objectives might be evaluated, and likely timescales for each metric.	José De Oliveira
major gaps in the availability of the relevant science: social.	John Powell
major gaps in the availability of the relevant science: economic.	Sasha Maguire
major gaps in the availability of the relevant science: biological.	Alex Kempf
Discussion: Identification of the advice needed to support the implementation of multi-stock management plans	
Discussion Identification of a range of modelling options and metrics for comparing revised management plans to be taken forward into the impact assessments. (for economic, biological and social outcomes)	José De Oliveira, Sash Maguire, John Powell
Preparation of a detailed work plan for the work necessary to evaluate the potential impacts of these options. (To be completed over the following days)	
0830-1730 Wednesday 30 November Preparation for IA for a new plan for cod, herring and sprat in the Baltic Sea. (To be completed into Thursday as needed)	
Brief summary of conclusions from STECF EWGs 11-01/11-07	
Overview and objectives (Commission RACs MS)	John Simmonds
Current status and management of Baltic herring and sprat (cod) stocks.	Stuart Reeves
Status of Multispecies modelling for the areas and mixed fisheries exploitation for fisheries Biological and fishery linkages between stocks in the area.	Tomas Groehsler
Discussion MSY objectives and linkages to multispecies and mixed fisheries.	Stefan Neuenfeldt
Discussion: Identification of fleet segments to be included	
Other objectives, relating to ecological and economic sustainability.	Eskild Kirkegaard
Baltic RAC (and MS) Objectives	Arina Motova, Katharina Jantzen
Discussion: Identification of candidate management measures that could contribute to the delivery of the objectives of the plan, including control and incentives.	Baltic RAC
Discussion: Identification potential metrics (by area) to determine how progress towards these objectives might be evaluated, and likely timescales for each metric. Including situations without assessments for stocks with no assessment or marginal assessments.	
Modelling options (including estimation errors - age, migration etc)	
Discussion of identification of the data, research and scientific advice needed to support the implementation of multi-stock management plans, according to the existing and future set-up of plans and identify major gaps in the availability of the relevant science in all three major areas,	Francois Bastardie, (Stefan Neunefeldt), Arina Motova

economic, social and biological.	
Identification of a range of modelling options and metrics for comparing revised management plans to be taken forward into the impact assessments. (for economic, biological and social outcomes)	Morten Vinther
Preparation of a detailed work plan for the work necessary to evaluate the potential impacts of these options. (To be completed over the following days)	Francois, Stefan, Arina Katharina, Ernesto Jardim
0830-1730Thursday 1 December	
Identify the contributions to the work that can be made by STECF and ICES, and co-ordination between the two.	
Any outstanding issues for Baltic multispecies work	
Any outstanding issues for 4 cod plans multispecies work	
1st draft of workplans	
0830 -1500 Friday 2 December	
Final draft of workplans.	
1500 Friday 2 December close meeting.	

4.4 Definitions

The current proposals for a reformed CFP anticipate that: "Multi-annual plans should where possible cover multiple stocks where those stocks are jointly exploited.”. One aspect of this aspiration is that plans might need to account for a variety of different linkages between the stocks in a given area. In order to distinguish between different types of linkage, the following terminology is used here:

- “Multi-species” refers to biological interactions that arise, e.g. from one species in an area preying on competing with another.
- “Mixed-fisheries” refers to technical interactions that arise from different species being caught in the same fishing gear at the same time.

“Multi-stock” is used as a generic term to refer to a plan that covers multiple stocks irrespective of how they are linked. It is useful also to define the basic concepts of exploitation. The terminology has evolved over the years. ICES (2003) initially considered three types of fishing units: the fleet, the fishery, and the métier. In 2008, the European Data Collection Framework (DCF; EC, 2008) retained only two concepts:

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

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

As such, the fleet describes the vessels while the métier(s) describes the fishing (activity/ies) in which the fleet engages. In this document fleet (segment) is explicitly used to describe a define set of vessels and métier the fishing operations. The term fishery is used in a general sense of activities that remove catch fish either as grouped vessels or several potentially variable métiers.

4.5 Participants

The full list of participants at EWG-11-15 is presented in section 8.

5 MULTI-SPECIES PLAN FOR BALTIC

5.1 Knowledge of the biological and technical linkages between stocks in the area.

5.1.1 Biological linkages between stocks in the area.

In the Baltic Sea, the fish community is dominated by only three species: cod (*Gadus morhua*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*). Within the context of a recent ecosystem regime shift at the end of the 1980s/beginning of 1990s (Möllmann et al. 2008), the fish community shifted from a cod- to a clupeid-dominated system (Köster et al. 2003). The initial mechanism behind this change was a climate-related change in the ecosystem leading to poor recruitment of cod (Köster et al. 2005). Low year-class strength and coincident overfishing resulted in a collapse of the cod stock initiating a trophic cascade involving an increase in the sprat stock and subsequent trophic cascade effects on zoo- and phytoplankton (Casini et al. 2008, Möllmann et al. 2008).

The present configuration of the ecosystem with domination by pelagic fish is hypothesized to be stabilized by newly-established predator-prey feedback loops. The dramatic increase of the sprat stock, which was supported by warmer, more favourable environmental conditions (Köster et al. 2003) has reduced the main prey of cod larvae (the copepod *Pseudocalanus acuspes*) (Hinrichsen et al. 2002) and exerted a strong predation pressure on cod eggs (Köster & Möllmann 2000).

Both Prey-to-Predator (P2P) loops seem to have had the potential to prevent recovery of the cod stock and a reversal of the regime shift (Möllmann et al. 2008, van Leuwen et al. 2008). Nevertheless recent assessments indicate that eastern cod has recovered once fishing mortality was reduced (ICES 2011). However, it remains unclear how these phenomena and processes vary between the different sub-basins of the Central Baltic Sea. Indications for local variability in ecosystem control mechanisms are lacking (or as yet undetected): cod egg predation by pelagic fish populations in the eastern basins, i.e. Gdansk Deep and Gotland Basin (Köster & Möllmann 2000) and spatially varying interaction strength between the pelagics and their predator cod (Neuenfeldt & Beyer 2006). Further evidence for spatial variability in the effect of pelagic fish on Baltic ecosystem functioning is the relocation of sprat and herring biomass to northern areas.

The northwards relocation of sprat and herring biomass to northern areas resulted in a decrease in prey availability for cod in its main distribution area, the Bornholm Basin (ICES Sub-division 25). Consequently, cod weight at age and fat content decreased. The decrease in lipid content and composition has under laboratory conditions been shown to decrease survival probability of cod larvae until first feeding, meaning that despite of the currently high spawning stock biomass of cod, recruitment might be hampered by the lack of suitable food for female adults. If the increase in the cod stock continues, another issue is that in the northerly basins, cod larvae will have to compete for food with sprat.

Cod cannibalism in the Eastern Baltic Sea was most intense in 1978-1984, a period with high juvenile abundance and large adult stock size. Multispecies modelling predicted about 60% of the 0-group and 30% of the 1-group cod were consumed by con-specifics (Neuenfeldt & Köster 2000). Subsequently, cod recruitment and adult stock decreased, while especially sprat, the main fish prey for cod, became significantly more abundant. Predation rates on 0-group and 1-group cod decreased to 23% and 9%. Since 2003, when cod stock size has increased again, predation on the 0-group increased, too.

However, predation on the 1-group has not increased again, yet. There is still less large cod as compared to the times of high cannibalism occurrence. The unchanged predation on age group 1 is hence a consequence of size structure at increasing adult cod biomass during recovery. It is, however, to expect that also predation on 1-yr cod is going to increase again.

5.1.2 Technical linkages between fisheries in the area.

The main target species in commercial fishery are cod, herring and sprat. They constitute about 95% of the total catch taken by fishing activities in the Baltic (areas 22-31).

Cod
More than 99% of the total Baltic Sea cod catches in 2010 was taken in subdivisions 22 to 26.

The main fisheries for cod in the Baltic use:
- demersal trawls (T90 with a cod end mesh size of 120 mm or trawl with 105 mm cod end mesh size and BACOMA selection panel 120 mm square mesh),
- gill-nets, (minimum mesh size 110 mm)
- pelagic trawls,
- longlines.

The cod catches by gear and area in 2010 are given in the Table 5.1.1 and for other species taken in the same fisheries (Table 5.1.2-3).

Gear	Subdivisions 22 -24		Subdivisions 25 - 32	
	Catch in t	% of total	Catch in t	% of total
Demersal trawl and Danish Seine	7939	50%	31129	62%
Gillnet and trammel net	4084	26%	7693	15%
Longline	310	2%	1945	4%
Pelagic trawl	65	0%	1958	4%
Other or unknown	3351	21%	7552	15%
Total	15749	100%	50277	100%

Table 5.1.1. Catch of cod in 2010 by gear and area. Data from STECF EWG 11-11.

Most of these fisheries are mixed fisheries with by-catch of flatfishes, which consists of, mainly flounder in Sub-divisions 25-28 and some other flatfish species in the Western Baltic. In some countries the majority of flounder by-catch is discarded (Latvia, Denmark, Sweden) while in some countries it is mainly landed (Russia, Poland). Usually the by-catch of flounder is higher in demersal trawl fishery and rather low in gillnet fishery.

It should be taken into account that survival of discarded flounder is higher than of other fish species.

Subdivisions 22 -24	Demersal trawl			Gillnet		
Species	Landings in t	Total Baltic landings in t	% of total landings	Landings in t	Total Baltic landings in t	% of total landings
Cod	8072	15749	51%	3698	15749	23%

Flounder	n.a.	16582	?	n.a.	16582	?
Plaice	1042	1560	67%	309	1560	20%
Whiting	625	1135	55%	10	1135	1%
Sole	59	119	50%	25	119	21%

Table 5.1.2. Species composition in landings in 2010 in western Baltic demersal fisheries by gear. Data from STECF EWG 11-11. Data on flounder catches by gear was not available to the expert group.

Subdivisions 25 - 32	Demersal trawl			Gillnet		
Species	Landings in t	Total Baltic landings in t	% of total landings	Landings in t	Total Baltic landings in t	% of total landings
Cod	33365	50277	66%	8404	50277	17%
Flounder	n.a.	16582	?	n.a.	16582	?
Plaice	401	1560	26%	73	1560	5%
Whiting	91	1135	8%	4	1135	0%

Table 5.1.3. Species composition in landings in 2010 in Eastern Baltic demersal fisheries by gear. Data from STECF EWG 11-11. Data on flounder catches by gear was not available to the expert group.

Flounder

A large part of flounder landings comes from the fisheries targeting cod, but there is also directed fishery mainly by static gears in the coastal area (gillnets, seines).

Herring and sprat

The main fisheries for herring and sprat in the Baltic use:

- pelagic trawls in mixed pelagic fishery,
- trap-nets, gill-nets targeting spawning herring in the coastal areas,
- demersal trawls targeting herring.

The pelagic trawlers catching a mixture of herring and sprat dominate pelagic fisheries in the Baltic (Table 5.1.4). The proportion of the two species in the catches varies according to area and season. Part of pelagic trawlers catches sprat and herring for human consumption, part for industrial purposes. The former could try to catch cleaner catches as they are intended for specific processing industry sector. For the latter the proportion of species in the catch could be of less importance.

The by-catches of other species in the pelagic fisheries are very low.

The landings in the Eastern Baltic by subdivision, quarter and species in 2010 is given in the table below. The estimates of pelagic catch com-positions are mainly based on logbooks and landing declarations, with limited supplementary sampling of catches. This could affect the quality of the assessment of both herring and sprat.

Table 5.1.4 Pelagic landings (‘ooo t) and species composition (%) in 2010 by subdivision and quarter

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
SD 25	Landings ('000 t)	20.0	21.0	10.0	5.9	**57.0**
	Herring (%)	33	26	87	81	**45**
	Sprat (%)	67	74	13	19	**55**
SD 26	Landings ('000 t)	59.5	33.5	6.3	19.8	**119.1**
	Herring (%)	17	18	23	31	**20**
	Sprat (%)	83	82	77	69	**80**
SD 27	Landings ('000 t)	35.1	12.9	0.1	1.0	**49.1**
	Herring (%)	32	23	88	59	**31**
	Sprat (%)	68	77	12	41	**69**
SD 28*	Landings ('000 t)	19.1	30.3	4.7	46.8	**100.9**
	Herring (%)	57	80	83	62	**67**
	Sprat (%)	43	20	17	38	**33**
SD 29	Landings ('000 t)	34.6	8.9	2.5	18.4	**64.4**
	Herring (%)	29	81	51	35	**39**
	Sprat (%)	71	19	49	65	**61**
SD 30	Landings ('000 t)	14.3	41.3	5.5	12.8	**73.9**
	Herring (%)	97	97	95	87	**95**
	Sprat (%)	3	3	5	13	**5**
SD 31	Landings ('000 t)	0.0	0.9	1.0	0.2	**2.1**
	Herring (%)		100	100	100	**100**
	Sprat (%)		0	0	0	**0**
SD 32	Landings ('000 t)	14.3	11.0	3.0	21.4	**49.7**
	Herring (%)	25	39	27	27	**29**
	Sprat (%)	75	61	73	73	**71**
Total	Landings ('000 t)	**196.9**	**159.8**	**33.1**	**126.3**	**516.0**
	Herring (%)	**34**	**57**	**68**	**51**	**47**
	Sprat (%)	**66**	**43**	**32**	**49**	**53**

*** Gulf of Riga included**

Consequences for management/assessment

As long as the catches of cod in subdivisions 27 to 32 remains at the very low level observed in the past 20 years it would be possible to consider the demersal trawl fisheries or the gillnet fisheries with mesh size => 110 mm in these subdivisions separately from cod in the management plan.

The majority of the catches of flatfish are taken in the same métiers as the cod and the impact on the flatfish of the management measures in the management plan should be taken into consideration.

The mixed nature of the pelagic trawl fishery which accounts for most of the catches of herring and sprat should be addressed explicit in the management plan.

Bycatches of other species in the pelagic fisheries do not seem to be an issue.

Denmark

1) Cod landings from the trawl fishery where a minimum mesh size of 110 mm and a BACOMA exit windows is mounted.
2) Cod landings from the gill net fishery using a minimum mesh size of 110 mm.
3) Herring landings from a directed fishery for human consumption carried out by trawlers using a minimum mesh size of 32 mm.
4) Sprat landings from a directed fishery for industrial purposes using a mesh size of 16mm.

Estonia

Estonian Baltic sea fishery is, in general, a trawl fishery and is directed mainly on herring and sprat. Pelagic trawls took, depending on region, from 40 to 99 % of total landings in 2004. The rest were taken as trap net catch of herring at the spawning grounds of herring.

Finland

Pelagic trawling is used to exploit Baltic herring stocks in the Baltic Main Basin, the Archipelago Sea, the Gulf of Bothnia and the Gulf of Finland. Many of the vessels use both pelagic trawl and demersal trawl or the same gear is used in both fisheries. Only few vessels are exploiting directly sprat stock, and sprat is the main by-catch in Baltic herring fishery. Herring trap-net fishery is conducted near the coast and inside archipelagos. Trap-net fishery for Baltic herring is conducted mainly during the spawning season in spring and early summer (May-June), targeting spawning component of Baltic herring stock.

Some demersal trawl vessels are targeting Baltic cod and they are mainly fishing in the Main Basin (SDs 24-25).

Germany

The German herring fishery in the Baltic Sea is conducted with gillnets, trap-nets and trawls.

In central Baltic all herring landings in this area were taken by the trawl fishery.

Sprat fishing fleet in the Baltic Sea consists of only one fleet where all catches for sprat are taken in a directed trawl fishery.

Cod is caught mainly with gillnets and trawls. In general, the German trawl fishery is a mixed fishery targeting cod, but with a by-catch of flounder (Sub-divisions 24 and 25) and dab (Sub-division 22). In recent years the by-catch of flounder has increased in gillnet fishery.

Latvia

Latvian herring catches are taken by trawls and by trap-nets. Latvian herring trawl fleet is operating only in the Gulf of Riga (Subdivision 28.1). There is small amount by-catch of sprat in herring trawl fishery in the Gulf of Riga and fishermen have spart quotas to cover this by-catch. Herring trap-net fishery is also important in the Gulf of Riga and it takes place from mid-April till the beginning of July.

In the Baltic Proper direct herring trawl fishery is prohibited and herring is taken only as by-catch in sprat fishery which is performed by pelagic trawls. The species composition should be recorded by the fishermen. The by-catch of herring in sprat fishery is variable and in some periods also clean sperat catches could occur.

The cod fishery is performed only by gillnets and trawls, which are mainly demersal. In some cases it is a mixed fishery with significant by-catch of flounder. In the majority of cases flounder is discarded.

Lithuania

The cod is caught by trawls and gillnetters (the share of landed cod in the latter is around 14%. In general demersal trawl fishery is targeting a mixture of cod and flounder with different proportions. Direct flounder fishery performed closer to coastal area. 99% of landed flounder is caught by demersal trawls.

44% of herring was caught by pelagic pair trawl and 54% by pelagic otter trawl. In general this is a mixed pelagic fishery when herring and sprat are caught together in different proportions dependently on season, gear and fishing ground.

Sprat is caught using OTM and PTM gears mainly in Subdivisions 25, 26 and 28 (Table 8). The landings are used for both industrial (mostly) and human consumption purposes. Almost 37% of sprat was caught by pelagic pair trawl and 64% by pelagic otter trawl

Poland

The pelagic vessels are targeting mostly pelagic species (sprat and herring).

Like in other countries the fishery of cod is mainly performed by trawlers and gillnetters, the former being slightly more important – 58% of the total cod landings in 2010. An important part of the Polish fleet targeting cod consists of small vessels $\leq$10 m working with gillnets. The catches of cod in recreational fishery could be substantial, although they are not included in the assessment, yet.

Russia

Pelagic trawlers are targeting sprat for the human consumption has average by-catches of herring between 7,7–23,1%. The species composition of the mixed catches is defined from logbooks and, partly, by observers

Demersal trawlers are targeting for cod and flounder.

Gillnetters are targeting for cod with small by catch of flounder

Sweden

The Swedish fishery for herring and sprat in the Baltic is carried out by four fleet categories:

Trawlers catching herring and sprat with a minimum mesh size of 32 mm. This fishery is for human consumption and for meal/oil.

Trawlers catching sprat (with a by-catch of herring) with a minimum mesh size of 16 mm. A part of the landings is used for human consumption. Most of the landings are used for industrial purposes. Herring is caught as by-catches in this fishery.

Coastal fishery for herring with gillnets. This fishery is for human consumption.

Purse seine fishery takes place near the coast for spawning herring in the second quarter of the year. This fishery is also for human consumption.

Most of the Swedish landings of herring and sprat from the Baltic are from pelagic trawls and also with bottom trawls for herring.

The Swedish fishery for cod and flatfishes in the Baltic is carried out by four fleet categories, all fisheries are for human consumption:

- Trawlers catching cod using Bacoma panel or T90 codend. Flatfishes are caught as by-catches in this fishery. A large part of the caught flounders are however discarded.
- Baltic gillnetters/longliners fishing for cod with a minimum mesh size in the gillnets of 105 mm. Flatfishes are caught as by-catches in this fishery. Longlines are starting to increase on the behalf of gillnetters in this category.
- Gillnetters fishing for flatfishes. Cod may be caught as by-catch in this fishery.

5.2 Approaches to incorporating the main linkages into multi-annual management plans.

Currently there is no integrated model that can give multispecies simulation and multifleet exploitation combined. Thus several modelling frameworks will need to be utilised. The multispecies links are discussed in section 5.2.1 and the exploitation modelling in section 5.2.2. Parameterisation of the modelling is only available for the area occupied by Eastern Baltic cod, sprat and Central Baltic herring. For the present single species models are available for cod, herring and sprat in almost all other areas. MSY modelling is available for these and can be replaced if multi-species targets as these can be developed.

5.2.1 Biological linkages between stocks in the area.

The density-dependent growth of herring and sprat will be implemented in the SMS forecast using a simplified version of the model presented in Casini et al. (2011) Generalized additive models showed that the spatial and temporal fluctuations in sprat density have been the main drivers of the spatio-temporal changes of both sprat and herring condition, evidencing intra- and inter-specific density dependence mediated by the size and distribution of the sprat population (Casini et al. 2011). Their model explained 97.2% of the model deviance for sprat, and 68.9% for sprat. Herring density was an additional albeit weak significant predictor for herring condition, evidencing also intra-specific density dependence within the herring population (Casini et al. 2011). In the first approach to implement this density dependence in SMS, a simplified non-linear model will be constructed, using herring and sprat densities only.

The dependence of cod growth on herring and sprat abundances will be estimated using a simple statistical model and subsequently implemented in SMS forecast.

Preliminary analyses indicated that temporal and spatial variability in weight at age of cod is mainly caused by variability in weight at age of the youngest fish considered in the analysis, i.e. age-group 3, while differences between growth rates of older fish have shown to be limited, both in a temporal and in a spatial comparison. For this reason, the statistical analysis of weight at age will divided into (a) a regression model for the weight at age 3, and (b) estimating von Bertalanffy growth parameters independent of external forcing for age groups 4+. Cod of age-groups 0 to 2 will not be included in the analyses, because they do not at all or only to a very limited extent feed on clupeids.

A simple model is going to be fitted to the cod weight at age 3 data:

$$w(3) = \frac{w(3,\max)}{1+\exp(\gamma(CLU - CLU_{0.5})}$$

In this model, w(3,max) is the asymptotic weight at age 3, w(3) where a further in increase of CLU (the number of clupeids per cod) will not lead to an increase in cod age 3 weight. CLU0.5 is the half-saturation constant, and γ encompasses all processes involved in the conversion from prey availability per cod to weight. In preliminary runs, this model explained 82% of the variability of w(3) and was highly significant (P<0.001). The residuals were normally distributed (Shapiro-Wilk test, P>>0.05).

Weight at age 4+ will be predicted using March survey data for ages 4 to 7 in a Ford-Walford plot. In the Ford-Walford plot usually Length at age a+1 is plotted on the y-axis against length at age a on the x-axis. Hence, L(t+1)=aL(t)+b. When growth data are given in terms of weight, fitting of growth curves is most easily done by using the cubic-root of the weight as an index of length. Regression a=0.9968±0.04461 (s.e.) and b=0.1455±0.05186 (s.e.) (r2=0.90, P<0.0001).

Using the number of clupeids per cod as a measure for prey availability, weight at age 3 in the first quarter of the year can be predicted based on the above mentioned relations. Weight at age 4 can be predicted based on weight 3 and the parameters estimated by the Ford-Walford plot. Subsequently, weight at age 5+ in the first quarter of the year can also be predicted based on the F-W plot. What lacks is the seasonal development of weight at age. As a starting point for predictions, the seasonal trend can be derived by scaling quarters 2 to 4 to the estimated quarter 1 values using an average seasonal development.

ICES Sub-division based values for predation mortalities of herring and sprat will be derived in the hindcast SMS by accounting for the distributions of cod, herring and sprat when estimating the prey-specific consumption rates of cod. This implementation needs cod stomach content data by ICES sub-division. These data have already been compiled. However, as well as in the other SMS hindcast runs, the material might be outdated, because the sample are from the period 1979 to 1993, and no later samples are include in the cod stomach content database. Furthermore, necessary for this implementation is data by sub-division, year and quarter on the relative distributions of the species. These data have already been derived from the Baltic International trawl survey for cod, and the acoustic survey for herring and sprat. Not all quarters have been covered, and the data substitution is detailed in table 5.2.1.1.

Table 5.2.1.1 Usage of survey data to calculate the relative distributions of cod, herring and sprat in the Central Baltic Sea.

	Cod	**Herring**	**Sprat**
Quarter 1	*Before 2000:*	Acoustics Oct/Nov	*Before 1999:*
	BITS Feb/Mar		Acoustics Oct/Nov
	After 2000:		*After 1999:*
	BITS Feb/Mar		Acoustics May
Quarter 2	*Before 2000:*		*Before 1999:*
	BITS Feb/March		Acoustics Nov
	After 2000:		*After 1999:*
	BITS Feb/Mar		Acoustics May
Quarter 3	*Before 2000:*		Acoustics Oct/Nov
	BITS Feb/March		
	After 2000:		
	BITS Nov		
Quarter 4	*Before 2000:*		Acoustics Oct/Nov
	BITS Feb/March		
	After 2000:		
	BITS Nov		

Finally, the sensitivity of cannibalism estimates to the rare occurrence of cod in cod stomach will be analysed using different subsets of the stomach content data in an SMS hind-cast.

5.2.2 Technical linkages between fisheries in the area.

It has been acknowledged that single fleet and non-spatial fishery modelling approaches might lead to bias in the outcomes of MSEs by ignoring the effect of heterogeneity of fishing practices and spatial effort allocations on various components of the stocks. Stress may be put on the spatial dimension of the exploitation of harvested stocks and dynamically integrate the combined effect of fleet, stock and management dynamics and to project the relative effect of different 'what if' scenarios. The resulting relationship F-stock is the conjunction between the diverse spatio-temporal fleet activities and the variable spatio-temporal stock availability.

Details that concerns the linkage between the population and the fisheries dynamics are provided in Bastardie et al. (2010) where the development of a fleet- (métier-) based bioeconomic model evaluating the 2008 cod management plan in the Baltic Sea within a Management Strategy Evaluation framework (MSE) is reported. The application has been used for impact assessments of Baltic cod so far, but the procedure can be extended to apply for the sprat and herring stocks. Modelling of fisheries dynamics can also be done.

1- The modelling of effort is explicit, so that the overall stock-F is an aggregation of fleet-specific Fs, knowing fleet specific catchability and spatio-temporal allocation of fishing effort,

2- The age-structured population is spatially explicit and age-specific migration occur within the year.

Briefly, the relationship between the spatially disaggregated *E* and the resulting *F* is the core of the operating model OM, linking the population dynamics and the fishery. A linear relationship is assumed:

$F_{fl,ag,se,ar} = Q_{fl,ag} E_{fl,se,ar}$ Equation 1

The dimensions are fl for a fleet segment (i.e. a combination of a country co, a vessel category vc, and a gear component gr and mesh sizes, consistent with DCF fleet segments e.g. DNK_18-u24_OTB_DEF_70-99), ag for fish age, ar for area, and se for season. The catchability composite term, *Q*, quantifies factors other than fish availability (abundance), which can impact the catch rates:

$Q_{fl,ag} = q\, Sel_{ag} Pow_{fl}$ Equation 2

Relative catching power (Pow) per fleet segment [Equation (2)] is deduced by applying generalized linear models on cpue data (for a given period of time) as a way to standardize the nominal effort. Catching power indices are calculated relative to the catching power of a Danish trawl-fleet segment of medium vessel size chosen as reference. An overall ogive for selectivity Sel is deduced from the overall exploitation level given by the assessed *F*. *F*-at-age is scaled to the maximal *F* over the 3 years before the start of projection. Gear-specific discard ogives might play a minor role in our application because discards are mainly of cod aged 1 whereas our population recruits to the fishery at age 2. Unless data is provided, the discard ogive will reflects the observed situation for a given year assumed to be representative for the entire period covered. The calibration factor *q* [Equation (2)] is set at a given fixed value, i.e. the factor that scaled the simulated landings in for the calibration year to the observed ones for the fleet of reference.

The effort allocation model assumes so far a constant allocation of the effort between the fleet-segments, space and time. The total effort (per vessel) is then scale up/down according to available fishing opportunities. Routines for altering/reallocating the effort allocation have been/are to be developed according to given scenarios (e.g. spatial closure, directed reallocation) and/or presumed responses of the fleet-segments to stocks fluctuations and/or regulations.

The respective stock dynamic of the sprat, herring and cod will be interlinked (accounting for species interactions M2) by incorporating the SMS model (see section 5.5.1) into the fleet-based framework. In brief, the fleet-based model could predict the yearly area-based Fs (e.g. ICES Baltic subdivision) from spatial and temporal fleet-segment activities (at the end of the year) to be input into the SMS model to draw the next N-at-age for the coming year of each of the stocks, also accounting for observation and stock assessment errors. Implementation error is still up to the fleet-based model.

Choosing the fleet definition to incorporate into the model is an issue when conducting the economic impact assessment because the DCF fleet-segments do not have the same level of sampling for economic or the fleet activity variables(The Commission Decision (2008/949/EC) of the 6 November 2008 describes in detail the Multiannual Community Programme to support the DCF). DCF economic fleet-segment (Appendix III - Fleet segmentation by region) are at a more aggregated level than the DCF fleet-segment for activity (Appendix IV- Fishing activity (metier) by region). In this context it expected that disaggregation chosen will be at the most disaggregated level available (the fishing activity Level6 per fleet) at the metier level and aggregate in the model when combining the economic aspects.

Furthermore, the fleet definition for the pelagic fisheries may not be sufficient to separate some activities targeting one species at the time, unless the DCF level6 (mesh size) is enough to inform on the target species (The ideal case would have been to use trip-based data where the targeted species can be identified), however, currently this is not available and may not be accessible on the anticipate timescale for the work.

5.3 Other objectives, relating to ecological and economic sustainability could be addressed within a management plan, and how progress towards these objectives might be evaluated.

5.3.1 Socio-economic objectives

Following the overall objective of the CFP, namely, 'to ensure that fishing and aquaculture activities provide long-term sustainable environmental conditions to reach an economically and socially sustainable fishing industry that contributes to the availability of food', the following economic objectives could be addressed within multispecies management plan:

1. MEY or maximization of either GVA, GCF or economic profit[1];
2. Self-sufficient fleets;

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[1] Calculated following methodology presented in AER:

Gross Value Added (GVA) = sum(Value of landings + Income rights + Other Income) - sum(Energy Costs + Repair and maintenance Costs + Variable Costs + Non-variable Costs + Rights Costs)

Gross Cash Flaw (GCF) = sum(Value of landings + Income rights + Direct subsidies + Other Income) - sum(Energy Costs + Wages and salaries of crew + Repair and maintenance Costs + Variable Costs + Non-variable Costs + Rights Costs)

Economic Profit = sum(Value of landings + Income rights + Direct subsidies + Other Income) - sum(Energy Costs + Wages and salaries of crew + Value of Unpaid Labour + Repair and maintenance Costs + Variable Costs + Non-variable Costs + Rights Costs + Annual Depreciation + Opportunity costs)

3. Ensuring the competitiveness of the sector in the world wide market;
4. Ensure local food supply and positive trade balance;
5. Price stability on a member state and market level;
6. Optimum capacity utilization;
7. Stabilization the employment rate in the sector in particular protecting small national communities and national heritage though incentives given to the sector by each MS.

Most of these targets are general and descriptive, rather than quantitative. Some of them could be used as overall CFP targets, others, such MEY, is could become an economic target of the long term management plan.

It is important, that the economic objectives be evaluated in a long term perspective, ensuring stability in the fleets and long term perspective for fishermen and the sector.

5.3.2 Additional operational aspects of interest to Baltic RAC.

Flexibility to catch cod from one management area under TAC of the other management area.

The present high biomass of Eastern Baltic cod is concentrated in the western part of the stock area, bordering Western Baltic cod stock area. Sudden changes in the age composition of cod caught in the western Baltic and changes in the fishing grounds signal an invasion of "Eastern Baltic cod" into the stock area for the other stock. The industry suggested there should be a higher degree of freedom to catch cod where they are.

In the present situation with a large East stock and a low west stock, an increase of the catch of cod in the western stock area will increase the risk of overfishing the western stock. It is therefore pertinent that it can be shown (e.g. otholits analysis) that the catches of cod in a border area can be taken with a very low "by-catch". Present knowledge on stock distributions in relation to density and environmental parameters is probably insufficient to do a realistic evaluation. As the present the proposed new work for the MSE does not include the western cod, it will not be possible to further investigate this option. However, a 10% flexibility might be considered as a worse 10% increase in F over target. If the Target F is the single species MSY value of 0.33 or less than 0.45 it is possible this can be considered from the earlier evaluations (STECF EWG 11-07) where F has been evaluated over a wide range for Western Baltic cod. This will be tested if time permits.

Reduction of unwanted by-catches

It was suggested that objectives to reduce unwanted by-catches should be included in the MP. This include both by-catches of other fish species than cod (e.g. discard of flounder) and cod below the minimum landing size. With the present time frame, a not existing ICES assessment and an unclear stock identity of flatfish in the Baltic, it will not be possible to make a realistic evaluation of the potential measures to reduce by-catch. Discard of cod is already included in the MSE.

Harbour porpoise is taken as unwanted in especially the set net fisheries from both cod and flatfish. Harbour porpoise is a protected species in the Baltic Sea and measures to reduce by-catch exits (Council Regulation 812/2004). The evaluation of introducing additional measures for reducing by-catch of harbour porpoise (e.g. reduction in the use of set net) will require a significant workload, and will not be done without a clear request from the Commission.

5.4 Candidate management measures that could contribute to the delivery of the objectives of the plan

5.4.1 Tactical approaches for cod fisheries from EWG 11-07

STECF recommends that management plans should be developed with a range of potential tools available to manage the fisheries. Past experiences show that it is important that a management plan includes options for actions to be taken in case the TACs are shown to be ineffective in limiting fishing mortalities. Managers should choose a minimum set of control measures that are thought to be appropriate at the time, but should retain the ability to relax or deploy additional tactical methods (eg. TACs, Effort controls, technical measures) should the plan be failing to deliver its objectives.

Management through limitation of catches

The current enforcement of the TACs appears to be sufficient to control the total outtake. Discards have been relative limited and stable in recent years and the EWG concludes that the currently TACs have been effective in limiting fishing mortalities.

F target based harvest control rules with catch calculated using a short term forecast and a percentage constraint on inter-annual change in TAC are considered appropriate in defining the TACs for both stocks. However, the simulations presented in section 7 indicate that a 15% constraint on inter-annual variation in the TACs is not required to achieve the biological objectives.

Although discards appear at present not to be a problem in relation to limiting fishing mortality, a management plan should include explicit rules for addressing discards. This could be implemented by defining the TAC as total allowable catch and by ensuring that all catches (landings as well as discards) are counted against the TAC.

Recreational catches constitute, in certain areas, a measurable and variable part of the total catches and to ensure a proper limitation of total catches, catches of cod in the recreational fisheries should be addressed in the management plan.

Limitation of fishing effort

The evaluation of the present multiannual management plan, and the simulations presented in section 7, indicate that rules for effort limitations are not currently required to meet the biological objectives, as long as the limitations in catches are effective in limiting the fishing mortality as intended.

Spawning closures

The impact on the present spawning closures on the stocks and the fisheries is unclear but the measures are unlikely to have had a limiting effect on the overall fishing mortality and EWG concludes that spawning closures are not required to meet the biological objectives as long as the TACs effective in limiting the fishing mortalities as intended.

If spawning closures are included in a future management plan it is recommended that it is ensured that the timing of the closures matches the spawning periods of the spawning components to be protected.

Other measures (gear rules, MLS, etc)

A number of technical measures including gear rules, minimum landing size and maximum by-catch percentages currently included in the technical measures regulation affect the fisheries on the cod stocks. These measures have little impact on the overall fishing mortality and are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended.

The measures may, however, have had a positive impact on the exploitation pattern on cod and as such a positive impact on the yield per recruit.

5.4.2 Baltic TACs and regulations for Pelagic stocks

The table below lists the TACs and landings for 2010 for herring and sprat stocks in the Baltic Sea. It is commented whether the TAC in 2010 was a restricting element in the pelagic fisheries. The table also compares the ICES advice for 2012, and the TACs implemented (October Council decision in 2011).

STOCK	TAC 2010	Landings 2010	Restrictive?	TAC 2012	Advice 2012
WBSS Herring	56.6	55.2 (42**)	yes	?	50.7 (42.7**)
Central Baltic Herring	126*	127.6*(136.7)	yes	78.4*	92***
Gulf of Riga Herring	36.4	35	yes	30.6	25.5***
Bothnian Sea Herring	103.3	71.7	no	106	104
Bothnian Bay Herring		2.1			2.1
Baltic Sprat	380*	315.9*(341.5)	no	225.2*	242

*Only EU Share
**WBSS only
*** by stock

The following regulations are presently in force in the pelagic herring and sprat fisheries in the Baltic Sea:

- Most pelagic fisheries take a mixture of herring and sprat and this contributes to uncertainties in the actual catch levels. The reported landings of CBH have been well below the TAC in the period 1992–2002; since then the reported landings have increased and the TAC was fully taken in 2010. This may have resulted in an incentive for misreporting of herring as sprat. The extent to which species misreporting has occurred is not well known. **Since 2006 the restrictions on unsorted landings, and an obligation to ensure adequate sampl**ing may have improved information on catch data. In 2012, by-catch of herring and cod could be attributed to the sprat quota if <8% (herring) or <1% (cod) of the total catch.
- **No minimum landing size** is defined in the herring and sprat fisheries in the Baltic.
- **Special measures for the Gulf of Riga**: A special fishing permit is needed in this area, and fishing with trawls is prohibited in waters shallower than 20 m.
- **Minimum mesh size**:
  - Sprat >16 mm
  - Herring >32 mm in SDs 22-27 and >16 mm in SDs 28-32

5.4.3 Influence of compliance on the success of Multi-annual plans

In order to reach the proposed management targets compliance and enforcement issues have to be addressed and accounted for in the plan. Compliance is influenced by monetary and non-monetary incentives

Monetary incentives: Non-compliance can occur when the expected benefits from violating exceeds the benefits of non-compliance. The expected cost consists of the probability of getting convicted and the level of the fine.
Non-monetary incentives:

- General satisfaction of fishermen with the management system at large
- General level of compliance with the laws in the country
- Feasibility of the rule to the fisherman
- Perceived controllability
- Complexity of the rules
- Type of sanctions (fine, withdrawal of license, prison)
- Perceived fairness (level-playing field between users and MS)
- Financial situation at the business level.

Monetary incentives can be altered by national authorities primarily by changing the level of enforcement intensity and/or the penalty level. The expected costs of a certain level of compliance as well as the optimal level of enforcement can be estimated by fishery/fleet by applying the EU COBECOS model. However, running the model requires an extensive data collection and estimation efforts which cannot be achieved within the given time-frame.
There is no known general model to estimate non-monetary incentives at the moment. However, national and fisheries based studies have been carried out to address many of these incentives.

For each proposed management measure these factors need to be addressed:

- Is the management measure possible to control?
- If yes, how shall it be controlled (which control tools should be used)? Shall different strategies be applied for different parts of the fleet?
- What is the expected compliance to the management measure? At least by providing a ranking of likely non-compliance rates for different measures.
- What are the expected types of infringements to the management measure? The focus should be on the infringement types that have a direct impact of the stock.
- Is the control measure cost effective?
- What are the obstacles for the fisherman to comply with the management measure?
- Can incentives for compliance be created?

In order to assess the sensitivity to level of non-compliance likely compliance rates should be included in the modelling, if possible. That requires that compliance levels (probability) is obtained for the suggested management measures. Likely cost to maintain an acceptable compliance level should be estimated, if possible.

5.5 Data, research and scientific advice needed and identified major gaps in the availability of the relevant science.

In relation to modelling herring and sprat growth in the SMS forecast module, the existing model from the literature (Casine et al. 2011) has to be simplified in order to be used for forecasts in SMS, because some of the complexity cannot be projected forward. The condition measure used has to be modified in order to predict density dependent weight at age. This has already been done in Casini et al. (2010). It has to be decided whether to use survey data for herring and sprat weight at age, or if the weight at sea from the SMS input is going to be used for consistency reasons. In order to avoid 'negative growth', the model has to be re-fitted to actual growth (weight increment between *t* and *t+i*. The statistical model used will be a second order polynomial or similar.

In relation to modelling the dependence of cod growth on clupeid abundance, data and model exist. The regression will be updated using the data on cod weight at age and clupeid abundances from SMS.

In relation to deriving sub-division based values for predation mortalities of herring and sprat, the necessary distribution data will be derived from BITS and acoustic surveys as outlined in section 5.2.1. These distributions are a starting point, and might be improved if possible during the study.

Model parameterisation is possible for Eastern Baltic cod however. its not possible to parameterize a model suitable for Western Baltic due to resource and time constraints. The existing model has not been updated since 1997. This implies that currently modelling will be limited to Eastern Baltic cod, Central Baltic herring, and the majority of the Baltic sprat stock that is found in the same area. Where necessary, management of Baltic sprat in other areas will be inferred from this multispecies study. Existing single species models will be used or slightly modified for Western Baltic cod and herring in other areas. If future management is to be carried out taking account of multi-species interactions, this implies a continued need to collect the full range of data to keep parameterization of the models updated For example the most recent stomach data is form 1993 when cod abundance was low by comparison to the current estimates.

5.6 The options for revised management plans to be taken forward into the impact assessments

5.6.1 Single stock stock options for Cod

Single species MSY estimates by stock: cod from EWG 11-07, no additional work needed

5.6.2 Multi-annual management of pelagic fish stocks in the Baltic (ICES Advice 2009, Book 8, 8.3.3.1)

Some work has already been completed: EC requested ICES in 2008 to identify options for multi-annual management of the Baltic pelagic stocks based on the following form of Harvest Control Rule (HCR):

i. The sum of the regulated catches for the stock shall be set according to a fishing mortality of **[A]**
ii. Notwithstanding paragraph i above, the sum of the regulated catches shall not be altered by more than **[B]** % with respect to the sum of the regulated catches for the previous year
iii. Notwithstanding paragraph i and ii, in the event that the spawning stock size for the stock is estimated at less than **[C tonnes / appropriate model-specific units]**, the sum of regulated catches for the stock shall be adapted to assure rebuilding of the spawning stock size to above **[C]** …..

The work was carried out and the ICES response provided in 2009 was based on work of WKHMP 2008 and WKMAMPEL 2009. The table below lists the suggested reference points, and the targets presently used by management (ICES Advice 2011, Book 8):

ICES 2009	Herring							Sprat	
presently used	WBSS (=indicative)		Central Baltic (CBH)		Gulf of Riga (GOR)			Baltic (BS)	
Fishing mortality [A] (year-1)	< 0.25	0.25	0.22	0.16	0.26	0.35	0.35	0.4	0.35
Annual TAC variat. [B] (± percentage)	15		15		15	20	20	20	
SSB trigger [C] ('000 t)	None	110	800	?	60		60	400	?
Probability of SSB_{2015} <[C]	< 5% (110)		< 5%		< 5%			< 5%	
B_{lim} ('000 t)	110	= Btrigger	385	?	40		?	200	?
When SSB<B_{lim}	F = 0		F = 0		F = 0			F = 0	
F when B_{lim} <SSBy <[C]	Not applicable	FMSY	0.22*[(SSB_y-385)/(800-385)]	MSY trans., Fpa	0.26*[(SSB_y-40)/(60-40)]	0.35*[(SSB_y-40)/(60-40)]	MSY trans., Fpa	0.40*[(SSB_y-200)/(400-200)]	MSY trans.
SSB_{2015} ('000 t)			1 056		117	101		962	
$Yield_{2015}$ ('000 t)			190		24	29		256	

For use in the modelling framework for the development of a multispecies management plan, EWG 11-15 reviewed these proposed values. An update of the biomass reference points might be required due to the 2009-revision of the acoustic index used for the assessment of Central Baltic herring and sprat, and due to the apparent change of predation mortality for pelagic stocks in the eastern Baltic (at least partly caused by the increased cod biomass). Fishing mortality targets have been constantly updated in recent years. In addition, WKMAMPEL did not define a Btrigger value for Western Baltic Spring Spawning Herring, which would be required as input for the modelling.

In addition the studies carried out in WKMAMPEL were carried out with rapid reduction of F with SSB below Btrigger. ICES currently advises on a linear proportional reduction of F with SSB from F target at B trigger to 0 at SSB=0. If resources are available these options will be tested for herring and sprat stock.

(1) Revision of Acoustic Index/Indices in 2009 (post WKMAMPEL 2009):

- Central Baltic Herring(CBH):

	SSB 2007 (kt)	F 2007
WGBFAS 2008 (Basis for Management Plan)	727	0.16
WGBFAS 2009 (Revision of Acoustic Index)	538	0.24

->Conclusion: There is a need for a revision of SSB reference points.

- Baltic Sprat (BS):

	SSB 2007 (kt)	F 2007
WGBFAS 2008 (Basis for Management Plan)	910	0.456
WGBFAS 2009 (Revision of Acoustic Index)	538	0.24

->Conclusion: No need for a revision, even so some historic changes are apparent

(2) New M2 values from SMS for Central Baltic Herring (CBH) and Baltic Sprat (BS) will submitted in 2012.

->Conclusion: There is a need for a revision of SSB reference points mainly for BS and to a lesser extent for CBH.

(3) WBSS Btrigger was not defined in WKMAMPEL. Btrigger would be needed for a multispecies MP.

(4) Bothnian Sea Herring, which was not included in the proposed MP: The effect of productivity changes on Flim, Fpa and Fmsy, as well as proposed Ftarget (by WKMAMPEL 2009) will be evaluated during the next bechnhmark assessment in 2012.

For herring and sprat stocks ICES evaluations had faster rate of reduction in F below Btrigger than currently applied by ICES. These need to be checked, If possible two regimes should be tested for Gulf of Riga herring and all evaluations should be tested for sensitivity to noise bias in assessment/catch.

The SMS can in forecast mode produce equilibrium SSB and yield for combinations of target F and trigger points for the three species cod, herring and sprat. Trade-off plots of varying target and trigger points on predator and prey species (see Figure X.5 for an example) will be used to select a few combinations of target and trigger points to be taken forward into the impact assessments. The presently used single species targets and triggers will be included the combinations taken forward.

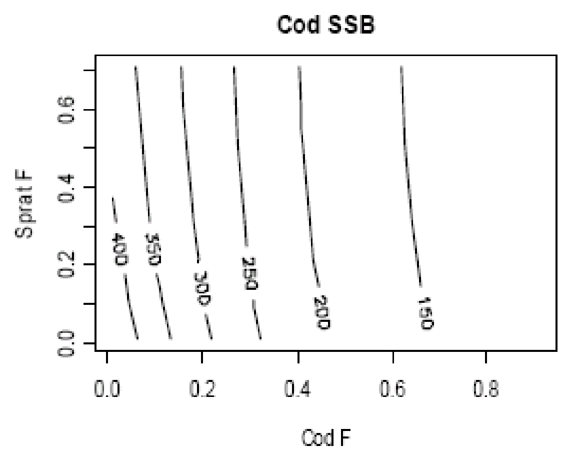


Figure X.5 Example of contour plot of cod SSB as function of the level of target fishing mortality for cod and sprat as estimated by SMS. Herring F is kept constant at F=0.19 (figure copied from ICES, WKMAPEL 2009)

The present large cod stock is concentrated in a rather small area compared to the historical distribution area. The high concentration might have led to food shortage and the observed decrease in condition factor of cod. It is essential to include spatial explicit options (e.g. closure of the fishery for sprat and herring in the area with the highest cod concentration) in the impact assessments. Right now it is not possible to specify the temporal and spatial extend of such areas, however the main concentration of cod can be derived from existing maps of catch per ICES rectangle.

A density dependent target F on cod might also be relevant to avoid food shortage, low growth, low quality of landed cod and very low stock sizes of prey species. The density of cod could for example be estimated from the number of cod within the 90% distribution area determined by survey data. It is not possible right now to specify details of such an HCR.

5.7 Work plan for the work necessary to evaluate the potential impacts of these options.

Topic	Description of work	Lead person(s) information required/ availability – time scale for work
Determination of extent of species data in Effort database	Checking which species Sprat, herring, flounder, turbot and flat fishes are available in the Effort Database at JRC. (Action already taken)	Hajo (JRC) to supply to Eskild / John
Multi species interactions Illustrative exploitation options	Provide updated multispecies M2 (from the 2011Eastern Baltic multispecies key run) to WGBFAS Update SMS (hindcast) model with relevant new knowledge and processes: • Area based M2: M2 value to be calculated by SD, Data: Stomach content by SD (exist) and stock distribution (first draft exist) • Sprat and herring density dependent growth Parameters and model taken from Casini et al. • Cod growth dependent on food availability. Parameters and model from Stefan Sensitivity analysis of cod cannibalism estimation from subsets of stomach content data. Update SMS forecast model with relevant new knowledge and processes. Use SMS (forecast) to illustrate the effect of HCR targets and trigger points for identification of candidates for F-target, and trigger points to be used in MSE. Rewrite the SMS (forcast) program such it can be used as "operating model" in MSE. Use spatial explicit, fleet based FLR-Baltic model in combination with SMS "operating model", for MSE **See below**	Stefan / Morten Jan 2012 Stefan / Morten Feb 2012 Stefan / Morten Mar 2012 Morten Feb 2012 Stefan / Morten Feb 2012 Morten Feb 2012 Francois
Conventional MSY targets	Cod from EWG 11-07 MAMPEL plans needed be checked/rerun based on simple HCR risk SSB below bloss blim to establish target F Btrigger Herring and Sprat.	Chris explore possibilities - JRC to consider.
MSE	MSE Workplan	Francois

	To reduce the work load and meet the deadline, it has been decided to limit the evaluation to the Eastern Baltic as a first step. o Obtain the up to date catch data (e.g., effort catch and landings per DCF fleet-segments, see section 5.5 and table below) o FLR/SMS coupling: replace the existing biological operating model by SMS (accounting for species interactions via the M2 matrix) and inform with the relative spatial distribution of the three stocks (distributions assumed constant in the forecast) o Implement the candidate HCRs (previously drafted from the SMS outcomes). o Make the DCF Fleet-segments consistent with economic AER ones (see section 5.5 and data table below). o Obtain and introduce with economic data in the model(variable and fixed costs and price formation, see section 5.5). o Decide on uncertainty ranges for stochastic simulations (from SMS simulations), including year correlation in assessment error.(Ask John) o Run the baseline forward, measure the performance and plot the multidimensional outcomes for cod, sprat and herring. o Run alternative 'what if' scenarios (robustness to errors and alternative HCRs) e.g. compare HCRs with single stock MSY targets vs. HCRs with multi-species MSY targets. <u>Data needs see table below</u>	

Economic evaluation	1. *Data collection.* The information, needed for the analysis, is already available at the JRC database. There is an issue with the data sets. There are differences in lengths classes of Baltic fleet segments, employment and effort data provided by the MS after transition from DCR to DCF. In order to have a consistent time series and clustering, data should be taken from DCF datasets (from 2008). The clustering of some of the segments, relating to lengths and gear classes, has to be well prepared in advance by JRC. . 2. Due to the shortage in time, use of 2008 and 2009 data should be considered as first priority. However, in case 2010 data are available, these should be incorporated in the analysis. If not, methods proposed by STECF EWG 11-18 should be used for short term predictions to estimate 2010 data, based on the AER using transversal data already available in JRC. 3. Some fleets (Germany, Denmark and Sweden) can be active in more than one sea. Therefore it is necessary to split the costs data per area. The methodology, provided by STECF EWG 11-18 and WS on allocation of economic data on disaggregated level held in Hamburg July 2010, could be used for this purpose. 4. Estimation of the current economic situation of the Baltic fleets. The multispecies management plan is likely to cover main Baltic stocks, which are currently restricted by TACs for single species and stocks; 5. Using FISHRENT or other biological or bio-economic model for the long term projections. 6. Evaluation of the possibilities to introduce spatial dependent costs and prices in the model. As it is presented by Ernesto (JRC) during the WG the costs and prices differ all around the Baltic Sea, so the spatial distribution would be of high importance in the future. However taking into account the timing of this assessment it is not feasible to produce such results by April. Within the next three months until the STECF EWG 11-15 Follow-up meeting for Impact Assessment for the Baltic Multi-species plan, the modelling of impact assessments is subject to certain time restrictions. Two possible options were discussed during the scoping meeting which could be	Arina/Katharina

	used for the current IA: I. the first option simulates the current status and reflects situation in the short term. For this option existing data from the AER and DCF could be used. II. the second option is to add economic constrains to existing biological models, including prices, costs, employment and estimating basic economic indicators (GVA, GCF, etc.). Additional data might be needed for this purpose.(see section on MSE workplan using FLR model above) Currently this option is proposed	
Enforcement in the Baltic	Survey for control agencies and scientific community in the relevant MS to collect: • Control and infringement data (number of controls and infringements by type of enforcement tool if possible and management measure). • Compliance estimations (%) per management measures. • Average cost per control and type of enforcement tool. Ranking of management measures bases on expected compliance. Litterateur study on non-monetary incentives??	Jenny Nord– before the next meeting. Jenny Jenny / Norman / John Powell

Data needed for Baltic multispecies MSE

DATA	PURPOSE	AVAILABILITY	DATA OWNER	DESCRIPTION	REMARKS
Effort	To Inform the effort per fleet/metier allocation model	Baltic countries in STECF effort data for 2010 Per DCF segments (DCF Appendix IV)	JRC	Effort (in days) per country per DCF vessel size per gear per mesh size per ICES rectangle per quarter	
Landings (weight)	To Standardize the nominal effort per fleet/metier from specific sprat herring and cod catch rate	Baltic countries in FishFrame for 2010 Per DCF segments (DCF Appendix IV)	DTU-Aqua data warehouse 'Fishframe' (hold in ICES soon)	Landings (in weight) per species per country per DCF vessel size per gear per mesh size per ICES rectangle per quarter	Within the Baltic Sea, countries LTU and FIN are not given by rectangle
Landings (value)	To Inform the additional revenue from "other" species (i.e., excl. sprat, herring and cod) by computing VPUE per DCF fleet-segment	??	??	Landings (in value) per species per country per DCF vessel size per gear per mesh size per ICES rectangle per quarter	If not available, VPUE_other=CPUE_other species * averaged price can be used instead?
Capacity	To compute properly the DCF segment - specific fixed costs (because fixed costs are per	Yearly figures in AER (2010?)	JRC	Number of (active) vessels per country per vessel size category (per month)	The figure is required per month, if possible.

	vessel)				
Variable costs	Inform running cost per day	Yearly figures in AER (2010?) Per DCF segments (DCF Appendix III)	JRC	Costs per DCF segments (for year 2010): costs depending on total revenue (e.g. sales costs and crewshare in % of revenue) costs for operating (e.g. fuel cost, ice, maintenance, etc. in cost per unit effort in day)	Need to be split per region using method from EWG 11-18 i.e. according to the respective effort? (e.g., Denmark, Germany between North Sea and Baltic Sea) No need to split further by rectangle (because fleet harbours are not localised)
Fixed costs (i.e. annual cost per vessel that do not depend on its running activity)	Inform fixed cost per vessel	Yearly figures in AER (2010?) Per DCF segments (DCF Appendix III)	JRC		Need the capacity to be properly informed
Price	Compute gross revenue from landings of sprat, herring and cod	Average price per species or Price equation per species (accounting for price flexibility)	A JRC database?		Evidences for price flexibility is weak (Ernesto). Mean price per species per DCF segment (Landings value divided by landings weight) has been used so far. Accounting for commercial categories would be a valuable refinement.

Based on the data requirements described on the table above, JRC has provided the data in December 2011. The table below summarizes the information provided, the level of aggregation required and provided and the source of information.

Data request for Baltic MSE and provision by JRC

NOT NEEDED currently (yellow) — UPDATED NEED (green)

Factor		Effort (2)	Landings (3) Value	Weight	Capacity (4)	Costs Variable	Fixed
Space	MS	X (E,$)	X ($)	X (E,$)	X (E,$)	X ($)	X ($)
	ICES SubDiv	(E,$)	**X** ($)	**X** (E,$)	(E)		
	ICES Rectangles	X (E)	X	X		X	X
Time	Year	X (E,$)	X ($)	X (E,$)	(E)	X ($)	X ($)
	Quarter	X (E)	X	X (E)	**X** (E)		
	Month				X		
Tech	Gear (1)	X (E,$)	X ($)	X (E,$)	X (E,$)	X ($)	**X** ($)
	Mesh size	X (E)	X	X (E)	(E)		
	Vessel LoA	X (E,$)	X ($)	X (E,$)	X (E,$)	X ($)	**X** ($)
	Target assemblage (DCF Appendix iv level5)	X		X			
	Metier	X	X	X		X	
	Vessel						X
Bio	Species		X ($)	X (E,$)			
	Age (catch-at-age)		X	(E)			
	Comercial categories		X				

Legend: X - required data; E - data available on the Effort database; $ - data available on the Economic database

(1) In the economic database gear allocation is based on the dominant gear, while in the effort database it follows the data call definitions which are based on the relevant regulation.
(2) Effort is defined in kw.days, gt.days and days at sea. In the case of data by rectangle, only hours fishing are available.
(3) The effort database also includes discards information.
(4) In the effort database capacity defined in number of vessels can be delievered in two distinct groupings, based on cod licencing scheme or based on gear/mesh size.
The second will repeat the vessel if several gears or mesh sizes are used.

6 PLAN FOR COD IN KATTEGAT, NORTH SEA, IRISH SEA AND WEST OF SCOTLAND

6.1 Knowledge of the biological and technical linkages between stocks in the area.

6.1.1 Biological linkages between stocks in the area.

The task of performing Multispecies assessments, including both expert group meetings and stomach sampling programs has been coordinated by ICES since the late seventies. The present ICES Working Group on Multispecies Assessment Methods [WGSAM (ICES 2011D)] met 10–14 October 2011. WGSAM provided a new "key run" for the North Sea using the SMS model (Lewy and Vinther, 2004), in which historical stock sizes, fishing and predation mortalities have been estimated. SMS is a stock assessment model including biological interaction estimated from a parameterised size dependent food selection function. The model is formulated and fitted to observations of total catches, survey CPUE and stomach contents for the North Sea. Parameters are estimated by maximum likelihood and the variance/covariance matrix is obtained from the Hessian matrix.

In the present NS key run the following predator and prey stocks were available: predators and prey (cod, whiting, haddock), prey only (herring, sprat, sandeel, Norway pout), predator only (saithe), no predator prey interactions (sole and plaice) and 'external predators' (8 seabird species, starry ray, grey gurnard, western mackerel, North Sea mackerel, North Sea horse-mackerel, western horse-mackerel, grey seals and harbor porpoise). The population dynamics of all species except 'external predators' were estimated within the model.

This section focuses on cod as predator and prey species. A comprehensive description of the biological linkage between all the species included in the key run can be found in the WGSAM (ICES 2011D) report (WGSAM (ICES 2011D) 2011).

Main key run results with focus on NS cod

The main cod diet includes several commercial species, where the biomass eaten of the various prey species depend on relative abundance and the biomass eaten by cod. Figure 6.1.1 presents biomass eaten by cod since 1963. Annual consumption of commercial species has varied from almost 2 million tonnes in 1971 to around 0.2 million tonnes in 2004. Main prey species include both the small "forage species" (sandeel, Norway pout and sprat), herring and medium sized gadoids (haddock and whiting). Cod cannibalism contributes also significantly to the diet.

Cod is prey for several species (Figure 6.1.2). Due to the fast growth rate of cod, it becomes unavailable for most small predators at age 1. The main natural consumption of biomass of cod is eaten by cod itself and in most recent periods, by harbour porpoise and grey seal.

The partial predation mortality (M2) by age (Figure 6.1.3) shows a rather stable annual value for the 0-group and a slight increase for age 1 and 2 cod. Due to the declining cod stock the impact from cod itself (cod cannibalism) decreases, but M2 increases due to the marine mammals. M2 on age 3 has increased significantly mainly due to the increase in grey seal abundance. Even though the abundance of harbour porpoise is assumed constant over the key run year range, the M2 at age 3 cod is increasing. This is due to a decrease in the availability of alternative prey (mainly whiting) and the assumed type II functional response, where a decrease in prey abundance will give an increase in proportion eaten.

NS Grey seal abundance, diet and consumption

The abundance of grey seal in the North Sea, as used in the key run, has increased from less than 10,000 animals in the early sixties to a population of around 100,000 in the most recent years. Seal diet, derived from scats sampled in 1985 and 2002 at haulout sites around the UK coast, show that between 5-20% of the seal diet (by weight) consists of cod (Figure 6.1.4). Both small and large cod are eaten (Figure 6.1.5). With an estimated daily food ration at 5.5 kg and a population of 100,000 seals, the annual consumption of fish is more than 200,000 tonnes.

NS Harbour porpoise abundance, diet and consumption

In the key run, harbour porpoise population size was assumed to be constant over the period and set to the average of the number of porpoises in the North Sea proper in the two SCANs years (224 100). Daily consumption was set to 2.4 kg, which corresponds to an annual consumption for the population at 197,000 tonnes of fish. According to the available diet data, 10-25% (by weight) of the diet is cod (Figure 6.1.6). Whiting is the dominant prey species.

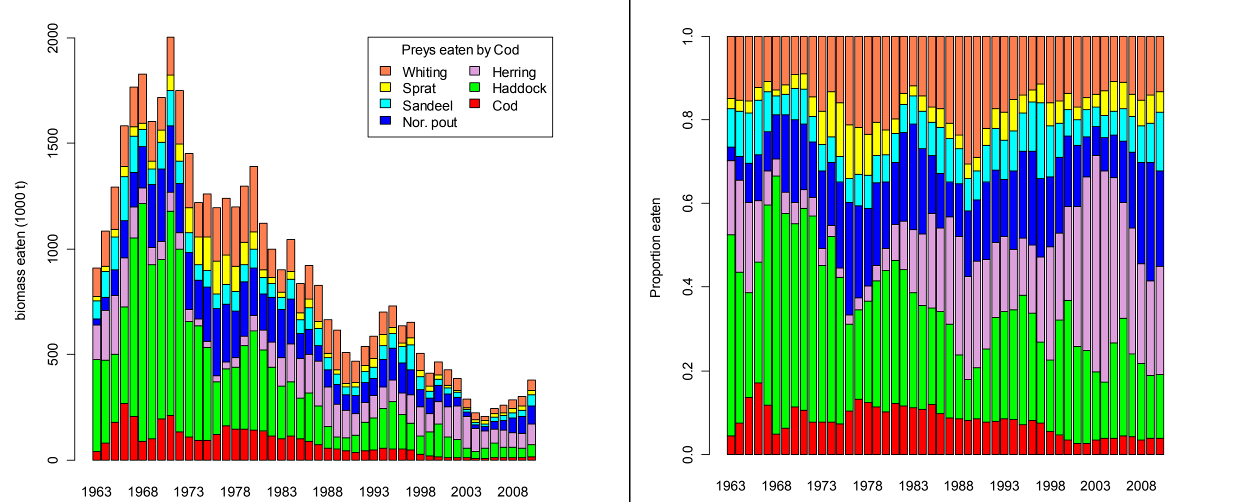


Figure 6.1.1. Biomass eaten by North Sea cod given by prey species and year a) total and b) by a proportion of diet by year.

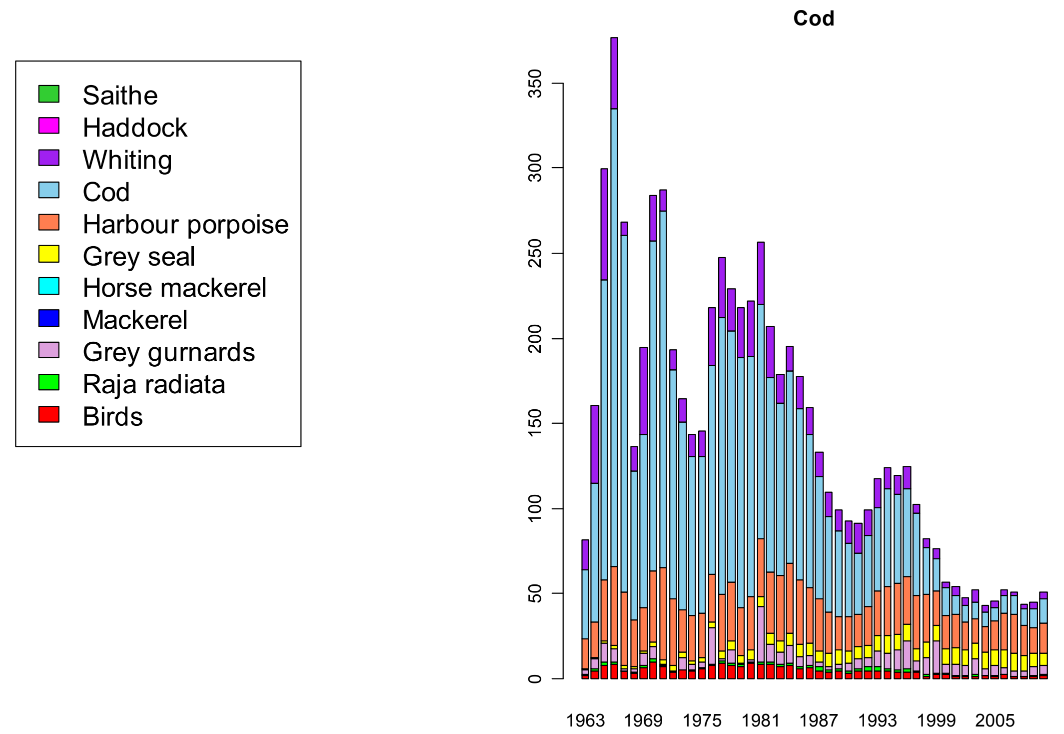


Figure 6.1.2. Biomass eaten (1000 tonnes) of NS codby predator species and year.

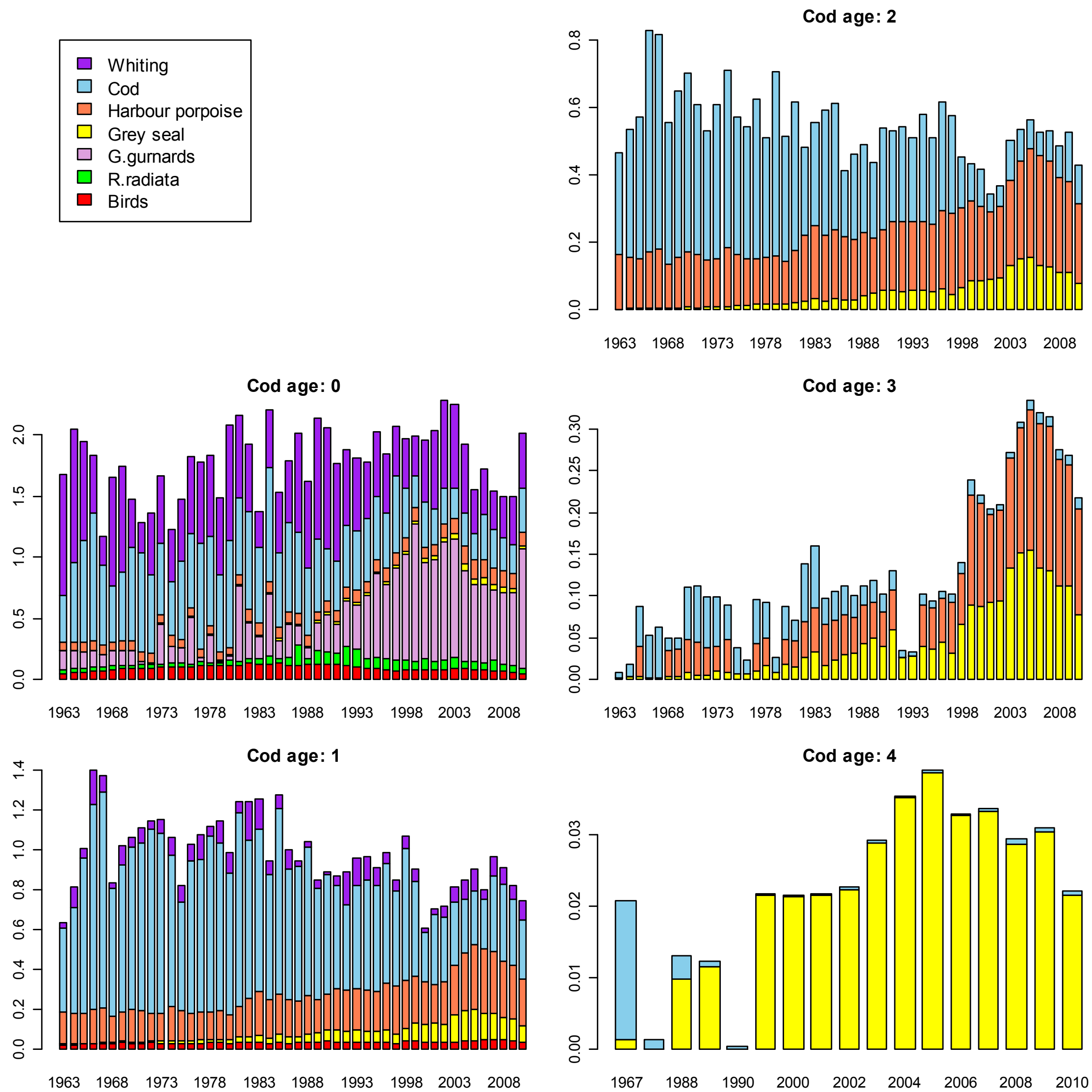


Figure 6.1.3. Partial predation mortality (M2) on North Sea cod by age by year.

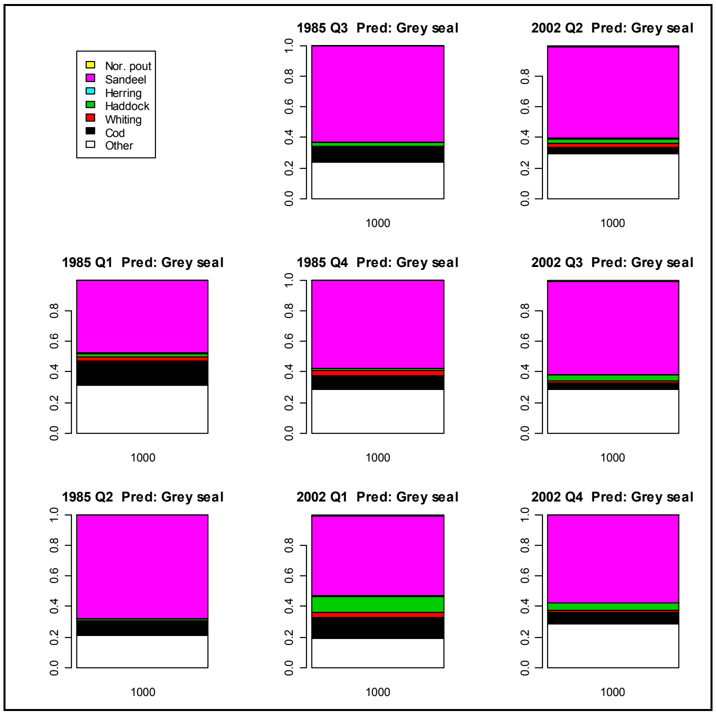


Figure 6.1.4 |North Sea Grey Seal diet (proportion by weight) for the four quarter of 1985 and 2002.

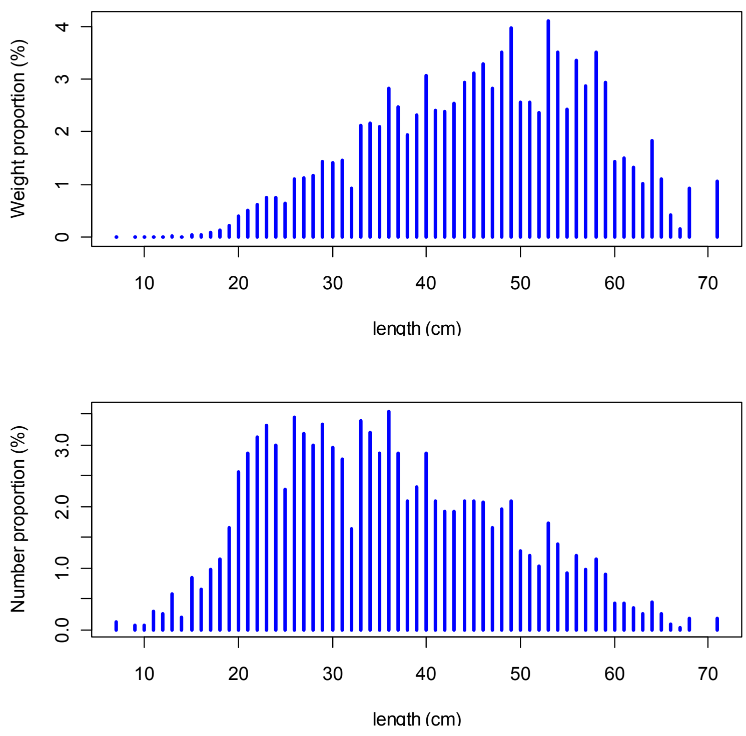


Figure 6.1.5. Length distribution of North Sea cod eaten by North Sea grey seals. Data from the 1985 and 2002 diet study are combined.

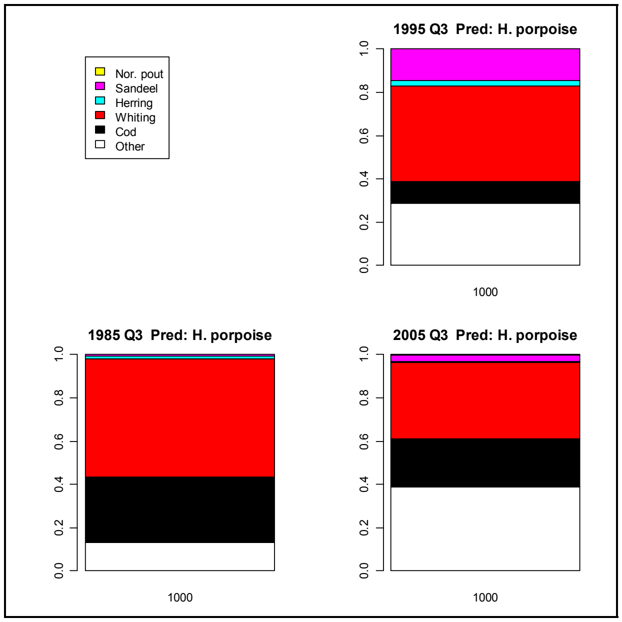


Figure 6.1.6. Stomach content of North Sea harbour porpoise derived from decadal diet composition from Danish and UK samples. All stomachs within a decade have been allocated to the third quarter for the "mid" year.

West of Scotland a grey seal diet study indicates grey seals cause considerable mortality on cod. Annual estimates of grey seal population are available from the Sea Mammal Research Unit (SMRU). Using consumption at length distributions and per capita consumption rates from the seal consumption study, the seal population estimates and cod age-length keys it has been possible to incorporate seal predation into a single species stock assessment model. Predation mortality at age and overall consumption of cod by seals is estimated for each year of the assessment time series.

Experiments with different seal feeding models lend support to cod as a preferred prey species for grey seals, i.e. for a given seal population predation mortality rate (M2) increases with decreasing cod stock biomass. No data however is available on the most important species in grey seal diet (sandeel) for West of Scotland making it impossible to assess whether changes in per seal predation mortality on cod are being driven by cod biomass or changes in the abundance of other species.

Cod, haddock and whiting are caught in mixed fisheries West of Scotland and research survey cruises confirm a strong degree of overlap between these species. A report documenting existing knowledge on the West of Scotland ecosystem with emphasis on importance to and influence on the three main gadoid species in the area, cod, haddock and whiting is available, (West Coast Forum report title(!) and reference). Incorporated in this report is a description of a full ecosystem model for the shelf area of ICES division VIa using the Ecopath with Ecosim (EwE) package. Results from diet studies for cod, haddock and whiting were available although the data for haddock is from the 1930s and 1950s. For other species, or species groups, within the ecosystem it was sometimes necessary to use diet composition and/or life history parameters from the same 'functional group' from another area (usually the North Sea).

Using the diet composition and life history parameters that allowed a balanced ecosystem in the initial year (no loss or gain of biomass) running forwards in time using fishing mortalities as driving data lead to poor fits to biomass estimates from single species stock assessments. Fits were much improved if the model was allowed to minimise sum of squares differences by varying predator/prey interaction (or 'vulnerability') terms but it is not possible to verify the appropriateness of the final vulnerability values. It is not considered appropriate to use a model such as EwE as a prediction framework to help formulate or evaluate a multi-species management plan.

6.1.2 Technical linkages between fisheries in the area.

The effort groupings in the current plan are only based on mesh size and gear type bands. These are broad and encapsulate a wide range of metiers. The relative contribution cod makes to catches of each of these is likely to be highly variable though potentially quite well defined in a spatial and temporal sense. The technical interactions between cod and other target species are equally diverse.

There are a number of examples that show species specific interactions with cod vary in space and time. As an example, an analysis of the catch profile of TR1 vessels (mesh size >100mm) sub divided into two mesh bands TR1s = 100-119mm and TR1b = >120mm shown in STECF PLEN-11-03 Figure 6.1.7. Analysis of the catch composition by cod management area shows that in some areas, the composition is quite similar e.g. 3C, whereas in others it can be quite different e.g.3D and 3B. In the first instance, this implies that within the current effort mesh bands there are sub-divisions that are operating differently and could be considered as distinct and separable management unit.

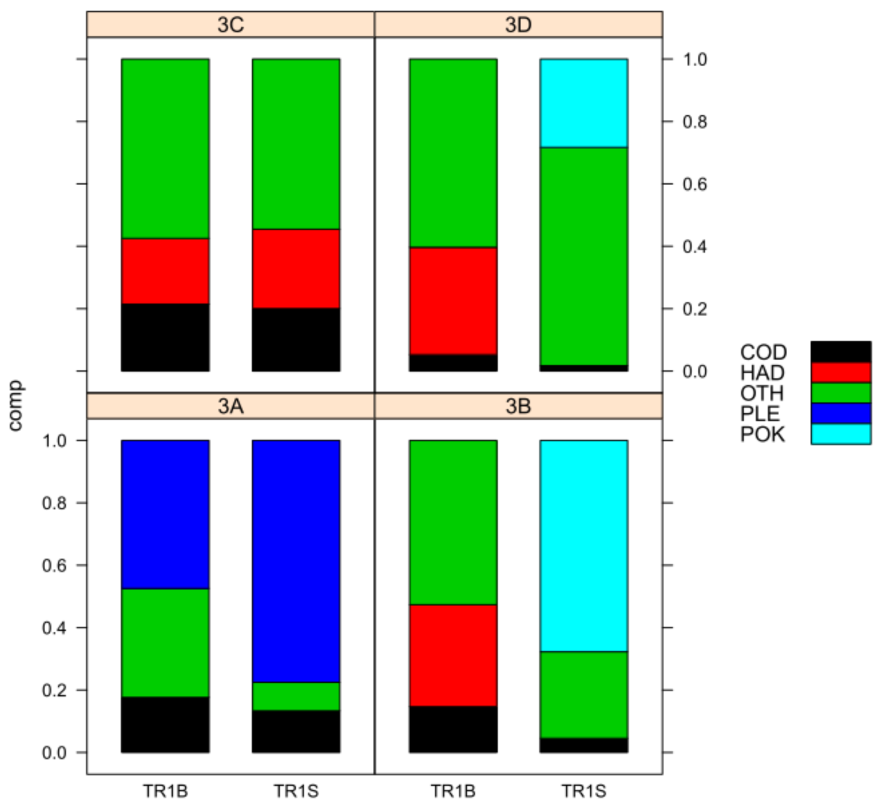


Figure 6.1.7. Contrast of catch composition of TR1 aggregated across member states by cod management area.

However, when the data is disaggregated by member state, the picture is far more complex (Figure 6.1.8).Noting that the analysis presented only relates to TR1 gears only and an extended analysis including all other effort bands will increase the complexity considerably. Given the level of complexity shown and the potentially difficulties of implementing management at a metier level, the inherent complexity that this would entail would probably indicate that management would be administratively inhibitive.

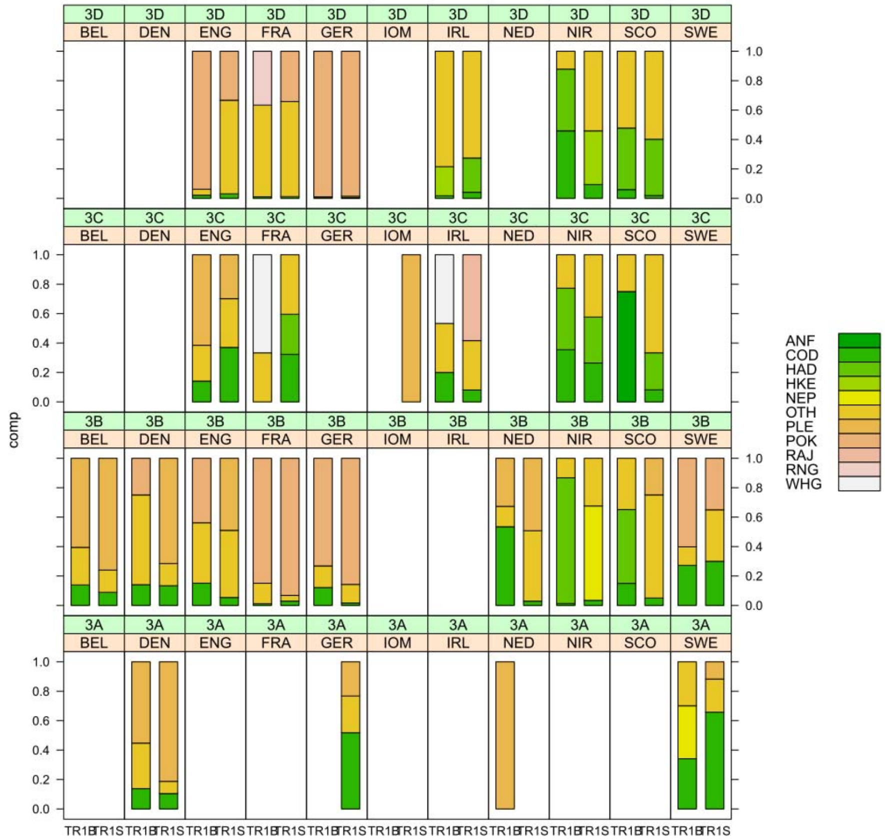


Figure 6.1.8. Contrast of catch composition of TR1 by member state by cod management area.

STECF-Effort Management data represents so far the primary source of information covering all cod areas and EU member states. Raw data submitted by MS can be extracted at a lower scale than described in the report (quarter and ICES Division for landings, quarter and ICES rectangle for effort), making it possible to investigate trends at the country, quarter and ICES division level. For the North Sea, ICES WGMIXFISH work supplements this through linkages with e.g. assessment results and catchability estimates. Both STECF-Effort report and ICES WGMIXFISH report (http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=446) contains comprehensive tables and figures describing the main technical interactions; which are not reproduced here (see for example p 49-51 in ICES WGMIXFISH 2011 the figures on landings by stock, country, fleet segment and year for the North Sea).

For the North Sea, the ICES MIXFISH delivers advice on how the various ICES single stocks short-term TAC advice are consistent with each other under a number of scenarios, including the expected effort reductions for the incoming year and the requirement for minimizing the risks of overquota catches of cod. This is based on considerations of stocks dynamics and recent trends in effort, catches and catchability by fleets (country, gear and mesh size group) and métiers (mesh size groupings).

This advice has been so far delivered in October (the ICES WGMIXFISH has met in August since 2009). For 2012, ICES has decided to change the schedule of the WGMIXFISH group, which will now convene and produce mixed-fisheries short-term forecast for the North Sea in May 2012, straight after single-stock assessment within WGNSSK (ICES 2011B). In this aim, WGNSSK and WGMIXFISH are currently establishing a common data call in order to provide catch and effort information at the level of the DCF metiers (or some aggregation of) into ICES InterCatch database, and thus insure that the data required for mixed-fisheries forecast are available in spring 2012. For the North Sea

WGMIXFISH will therefore be able to provide mixed-fisheries options that could be added into the existing options table of the single-stock ICES advice sheet for the June advice release.

There is furthermore a fundamental need to acknowledge the spatial differences occurring within the areas. Technical interactions are spatially and seasonally-driven. It would be useful to map the spatial and temporal activity to identify the spatial and temporal structure of cod, such analysis, if demonstrating areas of high cod abundance, could offer the potential to investigate spatial measures.

In the current data and knowledge, there is several ways to account for this. Approaches within ICES WGMIXFISH and STECF-Effort WG make this implicit only through the country record.

There is a lack of routine compilation of landings by ICES rectangle. Fishing activity by rectangle is available from the STECF – Effort WG but not landings. There are increasing needs and broader scope to map out this spatial distribution of landings by species, and the WG recommends that this is considered in future effort data calls. An alternative is to use information recorded by DCF RCM which is stored in FishFrame.

There is now increasing knowledge at detailed spatial scale through the use of VMS information. In many countries now, individual trip data at the level of VMS crossed with logbooks are available, and there are technics and skills in the labs to produce detailed VMS-based information at the national level (Eg Figure 6.1.9 for the Danish landings in Skagerrak and Kattegat). It might therefore be technically possible to compile such information at the international /region level. There are however, limits to how quickly this can be done due to manpower limitations and there are legal institutional barriers in some countries.

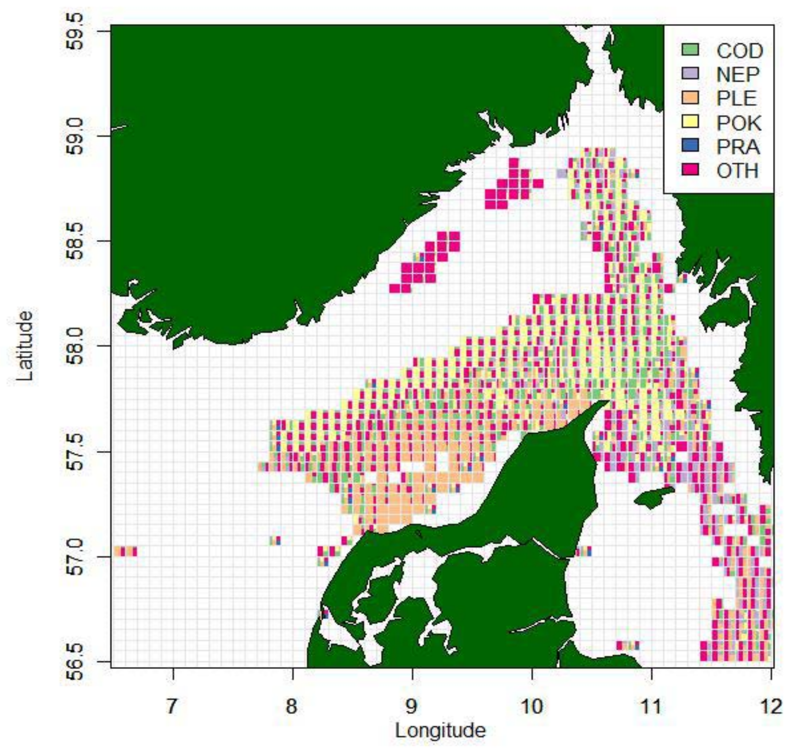


Figure 6.1.9 Spatial distribution of 2010 landings data by species for Danish vessels operating with otter trawl of 90-119mm in mesh size (i.e. metier OTB_DEF_90-119) in the Skagerrak and Kattegat.

WoS would be a good candidate for a detailed mapping of the spatial interactions across stocks, as the data could be collected and it is believed that the distribution is quite patchy. (Marine Scotland Science). IS and NS would be more difficult and it is not certain that this can be done before the next meeting.

In WoS and NS, the importance of Nephrops make a clear scope for some spatial considerations in management, fishing grounds are well identified and stable.

There is a need to distinguish between aggregated effort at the level of the whole segment (a proxy for "capacity") and the effort at the individual level. Histograms of actual effort by vessel could be provided for the various countries. It would be also interesting to know how national effort ceilings are distributed across vessels.

6.2 Approaches to incorporating the main linkages into multi-annual management plans.

6.2.1 Biological linkages between stocks in the area.

North Sea

Even though the newest key run (see sec 6.1.1.) and SMS software allow a full MSE in multispecies mode, such an analysis will not be done as it require a comprehensive analysis of objectives and performance measures (see e.g. the FP7 study MYFISH, Maximising yield of fisheries while balancing ecosystem, economic and social concerns).

The North Sea key-run results (see section 6.1.1) show that the temporal change in predation mortality (M2) of age 1 and age 2 cod is closely linked to the biomass of cod itself due to cod-cannibalism. M2 for age 3 cod has increased significantly in the most recent years due to the increase in grey seal abundance. To test the sensitivity of Fmsy to cod cannibalism and grey seal abundance a simulation program can be set up to estimate Fmsy using the present high partial M2 from the grey seal population and a density dependent predation mortality. A stock size dependent M2 can be derived from a simple (linear) relation between historical partial M2 and the population size of large cod (i.e. SSB). The result of this analysis might show the need for a stock size dependent target F in the HCR.

As a sensitivity test, the new estimates of M2 for cod can be used in the ICES cod assessment, and the result from this assessment can be used as basis for defining trigger and target points in a new HCR. With such an approach a fixed target F (Fmsy) is assumed, which is the case in most, if not all, HCR applied in the North East Atlantic.

West of Scotland

For the WoS incorporating seal predation into a single species stock assessment model for cod is considered the most important, and in the short to medium term the only scientifically tractable, means of incorporating biological linkages into a multi-annual management plan involving cod. It will only be known if the approach proposed will be accepted by ICES by the end of the ICES WKROUND (22-29 February 2012) and, if accepted, the first stock assessment of WoS cod using this method will be available in June 2012.

The multi-species models available do not provide any basis for prediction competition or interdependence of the species which supply the fisheries in these areas. Thus there is no knowledge of the need to take account of such linkages when managing species such as cod haddock and whiting in this area, and they can be considered as biologically independent.

Irish Sea

There is no multispecies model available for Irish Sea, so advice will be developed on single species evaluations and mixed fisheries considerations see below.

Kattegat

Any multispecies model available for Kattegat is subject to considerable uncertainty due to stock definitions within the area, with some stocks overlapping from East and or West, and some currently considered resident. Advice will be developed initially on single species evaluations and mixed fisheries considerations see below.

6.2.2 Technical linkages between stocks in the area.

There may not necessary be scope for a complete new design of a mixed-fisheries management plan at this stage. Cod remains the central focal point of the management, at least in NS, IS and WoS (KAT may be a bit different). Things would be different if there were several demersal stocks equally unsustainable. Therefore it might be more sensible to consider a cod-centralised approach in a mixed-fisheries context.

A possible meaningful approach to tackle the mixed-fisheries implementation error in a short-term perspective would be to append the existing cod plan with the following two elements: i) explicit consideration that the cod TAC, which baseline will still follow the currently established single-stock HCR, might be modified according to the mixed-fisheries (Fcube) advice and ii) improvements of the design of a number of articles, on the basis of the evaluation made by STECF EWG 11-07. Nevertheless STECF has identified that continuation with TACs administered as landings is unlikely to deliver reduced F is the immediate future. Some elements of how some articles might be improved are suggested below.

Mixed-fisheries advice will, as explained above, be readily available for the North Sea according to the procedures established by ICES WGMIXFISH. For the other areas, no similar mixed-fisheries advice is available yet. The WG considered that West of Scotland would potentially be the next candidate area for developing a similar approach, based on data availability and framing of the issues. Technical interactions in WoS involve cod, haddock, whiting, Nephrops and monkfish. A number of assessments for these stocks have been benchmarked by ICES recently, or will be benchmarked in January-February 2012. This might hopefully lead to more reliable F estimates. However, more work is needed for all areas except NS

It is suggested that the reliability of the STECF-effort Management data in WoS and their adequacy for conditioning the Fcube model is investigated. Of primary importance is the consistency of the total landings by stock and area between the STECF data and the ICES landings estimates used for assessment. If the two figures are consistent, then the F estimates can be proportionated to fleets and métiers (that can be defined from the STECF data). If they are not consistent due to area- misreporting issues, then the stocks F estimates cannot be easily split and the whole reliability of mixed-fisheries projections is undermined.

There is little support from the industry for the current effort limitations based on fishery and mesh size. Similarly, little support was expressed for further development of a LTMP based on fleets and métiers. The fundamental issues linked to fleet- and metier-based approaches relate to that i) fleets and metiers are rigid and aggregated categories that do not reflect the flexibility and the variability of individual vessels; as such, they are concepts used by managers (as a way to allocate fishing opportunities in a command-control system) and scientists (for sampling and raising procedures in order to estimate age distributions and discards rates for stock assessment, and for monitoring the impact of fishing activities on the ecosystem), but are much less appropriate for stakeholders in terms of basis for management. And ii) there are intrinsic difficulties in defining what are the relevant categories of fleet/ métier and how to allocate individual vessels/fishing trips into these, since different criteria can be used and the boundaries between different groups are often not clear-cut in demersal fisheries (see Ulrich et al., submitted). Métiers are intrinsically ephemeral, changing with time as businesses react to changing fishing opportunities, though they explain what is happening they may not be applicable as an allocation key or tool for management.

So a LTMP based on approaches such as Fcube and WGMIXFISH may not form the basis of actual management rules. They should rather be used for scientific monitoring of trends and evaluation of management objectives. Therefore, there might be a decoupling between defining and evaluating management objectives in the one hand, where these current approaches are useful and appropriate, and designing and implementing management measures to reach these, for which they may be less appropriate and priority should be given to considerations of incentives at the level of individual business.

6.3 Other objectives, relating to ecological and economic sustainability could be addressed within a management plan, and how progress towards these objectives might be evaluated.

6.3.1 Ecological objectives

As the ecosystems of the four cod stocks are complex (i.e. North Sea) or knowledge on species interactions is very limited (Kattegat, West of Scotland, Irish Sea) it impact assessments multi species/ ecosystem management plan must assume biological interactions are not currently predictable and advice must be based on the assumption that each species will recruit, grow and die independently in these areas. Therefore, additional ecological objectives on top of the standard single species objectives can only be taken into account indirectly.

During the implementation of the plan it has to be ensured that there are enough forage fish in the sea to sustain the cod stocks as well as other predator stocks in the ecosystem. As it is a general aim to keep all stocks above Btrigger (via having Fmsy as target or an escapement strategy for short lived species) this should be ensured unless the cod stocks recover to very high levels. At high levels of the cod stocks potentially also the sustainable exploitation of its prey species is in danger or fisheries have to be closed. The status of the food should be assessed regularly as done by ICES WGSAM (ICES 2011D). When the status of the food web becomes critical an evaluation and amendment of the different involved single species plans is needed as it is envisaged every 3-5 years anyhow.

A further ecological objective is to ensure that bycatch levels of sensitive species (rays, sharks, marine mammals) are not exceeded. This is so far not an objective of the plan. However, lower fishing mortalities in combination with effort management are expected to help to restrict the bycatch. If cod stocks recover substantially the TACs can become high although fishing mortalities stay low. STECF recommends not to use bycatch limits of other species based on % of catch but rather overall catch limits linked to an overall F objective. Therefore, lowering F on cod will serve to lower F on other species. After any substantial recovery, any objectives on the total bycatch of sensitive species could be included in future plans.

In general, Good Environmental Status has to be reached by 2020. This includes that the negative impact of fishing techniques on the sea floor and associated benthic species communities has to be minimized. A detailed evaluation on the negative impact of different gear types would be helpful but final conclusions are difficult to draw from studies carried out so far. Fishing opportunities should be amended accordingly if conclusions can be reached.

6.3.2 Social objectives

There are two overriding issues associated with understanding the social impacts of a revised management plan: first, there is an absence of baseline data on social aspects of fisheries, and second there is an absence of clear social objectives for fisheries management. Without clear objectives it is difficult to know how to draw boundaries around social impacts. The only indicators identified are employment and salary. While employment is a key measure of economic health it has limited utility in measuring social health in fishing communities, without knowing very detailed information on economic and social make-up of each community. Employment level within each fleet segment (or metier) might be more useful – because it is indicative of income levels, profitability, and fiscal health. But 'employment' is rather a blunt measure and does not pick up on subtle changes, for example, hiring migrant workers because they are cheaper than local people, reducing people from full-time to part-time or seasonal work, numbers of fishers who take on outside activities (e.g. crofting) to survive.

Two other concepts have been suggested in a previous study (reference sole and plaice?? 2006), as a means of measuring social impacts of management plans, resilience and reliance:

> Resilience is defined as: 'The extent to which actors, businesses and communities are resilient to changes in policy and management regimes, the health of the stocks and market forces, and capacity to adapt to external change.'
>
> Reliance is defined as: 'The extent to which the social and economic circumstances of actors, businesses, sectors and communities rely on North Sea fisheries – the significance of fisheries related activities is determined by the degree to which one relies on these activities for income, status, culture, etc.'

While both resilience and reliance are key to understanding social health, they are very difficult to measure without large amounts of information, and a detailed understanding of each individual community. Resilience requires understanding of social and human capital that exists within communities, measuring reliance requires deep understanding of the extent to which the local economy is dependent on fishing and associated upstream and downstream activities. An extensive list of information requirements was provided by STECF Working Group on long term management plan for NS plaice and sole (|STECF 2006).

It has also been suggested that to obtain a complete picture of social impacts of a management regime there is a need to explore relationships at community level, within institutions (public bodies) involved in management, and within the fishing industry itself. This indeed would provide a complex picture of social aspects but again is very demanding in terms of both data and man-power requirements and understanding relationships.

The Way forward

One way forward is to separate out 'direct' social impacts from 'indirect' social impacts. Direct impacts are those that impact directly on those involved engaged in fishing activities (i.e. vessel owners, vessel operators, crew). Direct social impacts should be the focus of any impact assessment, as they can be measured through current data sources, and through additional data collected from sampling individuals involved in fishing. We suggest that indirect social impacts are not measured in an impact assessment of a fisheries management regime. Indirect social impacts affect the wider community, for example, fish processors, purchasing and sales agents, engineering and other support services, families of vessel owners, operators and crew, and the wider community. Indirect impacts are very difficult to ascertain without large amounts of information and detailed knowledge of each fishing community (for example the extent to which communities are resilient and reliant), as many other factors are involved (e.g. for a fish processor it might be difficult to separate out changes in management plans from changes in market prices).

Impact assessment rules require that employment levels and salary are used as indicators of social impacts. Overall employment data is collected on an annual basis from all Member states and will provide a useful baseline indicator to assess changes as the new management plan is implemented. Salary data is also collected but is not a direct measure of the impact of management measures as salaries are influenced by a range of other factors (market prices of fish on landing, and other input prices affecting profitability such as fuel).

Employment of those directly involved in fishing (and salaries) as indicators of social impact can be enhanced through collecting a range of other information though sample surveys of vessel owners/operators (i.e. measures of both social and human capital). Such information will assist in interpretation of changes in employment and determine causes of change (e.g. whether a reduction in employment is due to investment in gear to make boats more efficient, or reduction in quota, or a switch in activities, or reduction in fish prices/increase in fuel costs).

Changes in social conditions can be measured through a series of indicators relating to:

- Changes in employment
- Sources of income
- Resilience
- Empowerment and competence

The resilience indicator will be derived using measures of cooperation, confidence, and investment in the particular fleet segment or metier. The final bullet point above requires the development of a new scaled question adapted to the particular conditions in the fishing industry. The indicators will be developed from a set of measures delivered through a fishermen survey. Proposed measures of social impacts would include the following:

- Level of input costs (fuel, repairs, new equipment, general supplies)
- Level of employment (increase/decrease)
    - Changes in nature of employment (e.g. migrants, FT to PT, reduced hours)
    - Reasons for change in employment level
- Owner/operator undertaking other work (diversifying sources of income)
- Crew undertaking other work (diversifying sources of income)
- Wife of owner/operator increased work to maintain standard of living/support survival of business
- Wives of crew members increased work
- Changes in way fish is landed/marketed
- Changes in nature of fishing trips (e.g. length/timing)
    - Reasons for change
- Level of investment in the business
    - Reasons for high/low investment
- Measure of confidence in future of the business

    - Reasons for high/low level of confidence
- Empowerment (a scale to measure perception of control over fishing activity)
- Competence coefficient (extent to which fishermen perceive they are able to apply their experience, knowledge and skill to maximum effect within a management regime). This would be a scaled measure from which we would derive a score.
    - Rational for answer given (e.g. reasons that support high scores, or explain barriers resulting in low scores)
- Changes in level of onshore support services
    - Reasons for change
- Level of cooperation (within industry/between industry and public management bodies)

Some of these indicators might be similar to those collected under economic impacts. The important issue is to understand the reasons for change, and not just collect data on the size/direction of change. The proposed measures will provide a mix of qualitative and quantitative data (e.g. employment and salary information – along with rationale for changes); competence coefficient and measures of empowerment will also be quantitative based on the development of numerical scales. What the measures will do is indicate and directions of change, and a rationale for whether the change can be attributed as a result of management regimes. To some extent changes in employment salary might also indicate the potential for indirect social impacts on the wider community in coastal towns heavily reliant on the fishing industry.

6.3.3 Economic Objectives for LTMP

Stated explicit and economic objectives are currently absent from the cod LTMPs, hence there is no clear intention against which the economic and social consequences of actions under the plan can be compared when management adjustments are considered. This raises the risk that either the environmental objectives will be achieved at a level of economic or social cost which partly or entirely offsets the benefits or implied but unstated valid (or not) economic objectives result in a failure to achieve biological objectives. In either case failure to state explicit objectives can cause problems.

There are, of course, economic objectives of the CFP, but these are vague and difficult to make operational; the overall objective of the CFP is to *ensure that fishing and aquaculture activities provide long-term sustainable environmental conditions to reach an economically and socially sustainable fishing industry that contributes to the availability of food*. As well as being weakly defined, for practical purposes neither is it clear how MS should interpret and jointly consider the broad CFP objectives alongside the more specific environmental objectives of the LTMP. For example, the current approach is for the specific LTMP objective to have implicit priority over the broader CFP objective – the former is the specific object of the plan, the latter is not. The implied assumption is that meeting the LTMP objective contributes to the high level CFP objective.

While there is a strong case for bringing economic objectives into the LTMPs – to ensure that the benefits to society are greater than the costs of adjustment – to do so poses a number of challenges. Economic objectives of fishing are political choices and vary between MS in the EU, so it is not likely that MS could ever all agree specifically on what they want the fishing opportunity to contribute to their respective societies, and how priorities should be ranked.

For the management plan there could be an overall economic aim that businesses exploiting the fishing opportunity should do so in a way that adds value to the economy, but the implications of that, that they should be subsidy-free and so on, are currently not necessarily acceptable to all MS. Fish stocks are a source of wealth and it is possible for fleets to exploit them without subsidies and to contribute positively to society, but the transition from a subsidised fishery to an unsubsidised fishery is not politically acceptable in some (many) MS.

In some MS there seems to be a social objective that could be roughly stated as maintaining or increasing current levels of employment (even if wages are low). It could be said that is not really appropriate for EU fishing management plans to have specific economic objectives (rather than general economic aims to bring benefits to national economies).

There is an agreed biological objective (MSY), albeit one that is not be exactly defined and cannot be achieved for all species at the same time. The management plan chosen will aim to achieve the biological objective of FMSY with a general underlying expectation (or assumption) among industry and policy makers that a bigger fishing opportunity will bring the possibility of the maximum economic benefits to countries. This could be expressed as, give us the harvest opportunity and leave us to ensure that we get economic benefits from it.

However, the economic impacts of harvest control rules (which is mostly what the plans comprise) can vary tremendously depending on how the opportunity is exploited. Therefore, the design of rules concerning fleet management and access to fisheries can influence whether the economic aims and objectives are achieved, given a certain fishing opportunity.

It is possible that by having different arrangements for fleet management and access to fisheries, MS with different economic objectives could both achieve their objectives given the same overall EU fishing opportunity. Potentially, whatever the total TACs for a group of species, different economic objectives could be achieved by different approaches to fleet and access regulations.

Possible Economic objectives

Some possible socio-economic targets could relate to the following list and ideally should be expected to be achieved and maintained in the long term:

- MEY
- Max (GVA / GCF / Profit)
- Competitiveness of the sector and food supply
- Price stability
- Efficient capacity utilization
- Employment
- Protection of small national communities and national heritage

However, there are some problems with using these ideas and concepts as economic objectives, in addition to the issue that MS are unlikely to have the same economic aims for fishing.

- MSY vs MEY: the plan follows the general aim of MSY (according to the CFP) and MEY would therefore difficult to achieve
- Reliability of data available to assess performance against objectives (actually quite good for Baltic Sea)
- For the Baltic, separation of German, Swedish and Danish fleets by area
- For the North Sea, Irish Sea and West of Scotland, separation of the national fleets fishing in those areas
- How to define a quantitative target ?

Secondly, economic objectives of fishing are necessarily political choices and vary between MS in the EU. It is therefore unlikely that MS could ever all agree specifically on how they want the fishing opportunity to contribute to their respective societies, and how priorities should be ranked. Following the diversity of political opinions among MS in the EU, it might not be appropriate for EU fishing management plans to have specific economic objectives.

There is an agreed biological objective; the management plan chosen will aim to achieve the biological objective of F_{MSY} with a general underlying expectation (or assumption) among industry and policy makers that a bigger fishing opportunity will bring the possibility of the maximum economic benefits to countries.

The economic impacts of harvest control rules (which is mostly what the plans comprise) can vary tremendously depending on how the opportunity is exploited. Therefore, the design of rules concerning fleet management and access to fisheries can influence whether the economic aims and objectives are achieved, given a certain fishing opportunity. There is clearly a challenge in integrating biological and economic objectives and finding appropriate management actions when measures to achieve the different objectives are potentially incompatible over the short run.

It is possible that by having different arrangements for fleet management and access to fisheries, MS with different economic objectives could both achieve their objectives given the same overall EU fishing opportunity. Potentially, whatever the total TACs for a group of species, different economic objectives could be achieved by different approaches to fleet and access regulations.

Economic constraints rather than economic objectives

An alternative approach to setting economic objectives for a long term management plan could be to set economic constraints instead. In practice this is what often happens informally through the political process. The idea is to say these are our biological objectives (to exploit the stock at FMSY for instance) and we will achieve that objective as soon as possible, subject to the constraint that we will not continue with a plan to achieve that objective if the costs of doing so are disproportionate to the benefits that are expected as a result of early achievement of the stock mortality objectives. In practice this might result in agreement not to make annual reductions in fishing opportunity of more than x% of the volume of allowed landings.

Another variation could be that we should only introduce management measures if they are cost effective to the society. This implies that impact assessment would require costs and benefits analyses of the long term management plan options, as indeed they do under the EC Impact Assessment board criteria.

Industry observers at the working group seem generally to support the concept of achieving the F objectives, but not at disproportionate cost. Their focus is likely to have been on immediate cost to existing fishing industry businesses.

Although the purpose of fishing is to deliver economic and social benefits to people, it is not clear at this stage whether it will be possible to get agreement even on economic constraints for a LTMP. The choice of those constraints, as is also the case for the economic objectives, is a matter of political preference.

It might, in the end, be appropriate to agree, that management plans should be "to ensure sustainable use of the resources", however other measures, such as market policy, should have purely economic targets.

The EWG recommends additional research should be carried out to look into the available options for adding economic objectives to the cod LTMPs and the estimated impacts of doing so. The following text is proposed as preamble and general aims for the terms of reference:

Economic objectives are currently absent from the cod LTMPs, hence there is no clear avenue by which the economic and social consequences of actions under the plan can be taken into account when management adjustments are considered. This raises the risk that the environmental objectives will be achieved at a level of economic or social cost which partly or entirely offsets the benefits. By bringing specific, operational economic and social objectives into the plan these risks are mitigated and the conservation goals of the plan can be achieved in a way that is balanced, credible and broadly supported by the range of stakeholders. Defining suitable economic objectives is challenging – they need to be practical and meaningful, politically acceptable and not undermine ultimate achievement of the overarching environmental aims. A potential solution to this challenge is to apply a Disproportionate Cost criteria as, for example, is the case in the Water Framework Directive and Marine Strategy Framework Directive. Under this approach MS can provide evidence to demonstrate that achieving the environmental objectives in the given time frame will involve disproportionate cost and offer a detailed alternative plan demonstrating how the goals will be achieved over a longer period of time. Disproportionate cost is not in itself a clear cut concept although it is generally interpreted as a situation where the costs from achieving the objective exceed the benefits of doing so.

The proposed work would investigate the possible options for economic objectives which are specific, operational, meaningful, politically acceptable and which support ultimate achievement of the environmental objectives. Any options identified would be appraised against a business as usual baseline. In particular the study will consider how Disproportionate Cost criteria could be applied and the likely impacts of doing so. This work will require significant input in particular from economists but also natural scientists in deriving yield estimates.

6.4 Candidate management measures that could contribute to the delivery of the objectives of the plan

6.4.1 Compliance and Enforcement

In order to reach the proposed management targets compliance and enforcement issues have to be addressed and accounted for in the plan. Compliance is influenced by monetary and non-monetary incentives:

Monetary incentives:

- Non-compliance can occur when the expected benefits from violating exceeds the benefits of non-compliance.
- The expected cost consists of the probability of getting convicted and the level of the fine.

Non-monetary incentives:

- General satisfaction of fishermen with the management system at large
- General level of compliance with the laws in the country
- Feasibility of the rule to the fisherman
- Perceived controllability
- Complexity of the rules
- Type of sanctions (fine, withdrawal of license, prison)
- Perceived fairness (level-playing field between users and MS)

- Financial situation at the business level.

Monetary incentives can be altered by national authorities primarily by changing the level of enforcement intensity and/or the penalty level. The expected costs of a certain level of compliance as well as the optimal level of enforcement can be estimated by fishery/fleet by applying the EU COBECOS model. However, running the model requires an extensive data collection and estimation efforts which cannot be achieved within the given time-frame.

There is no known general model to estimate non-monetary incentives at the moment. However, national and fisheries based studies have been carried out to address many of these incentives.

For each proposed management measure these factors need to be addressed:

- Is the management measure possible to control?
- If yes, how shall it be controlled (which control tools should be used)? Shall different strategies be applied for different parts of the fleet?
- What is the expected compliance to the management measure? At least by providing a ranking of likely non-compliance rates for different measures.
- What are the expected types of infringements to the management measure? The focus should be on the infringement types that have a direct impact of the stock.
- Is the control measure cost effective?
- What are the obstacles for the fisherman to comply with the management measure?
- Can incentives for compliance be created?

In order to assess the sensitivity to level of non-compliance likely compliance rates should be included in the modelling, if possible. That requires that compliance levels (probability) is obtained for the suggested management measures. The likely cost to maintain an acceptable compliance level should be estimated, if possible.

6.4.2 Role of Scientific Observers

Currently several elements of the existing cod plan require fleets operating under provisions of articles 11 and 13 to report catch (landings plus discards) to determine if cod catches are within predefined levels. This data is generally collected from national discard observer programmes. The primary role of discard observer programmes is to gather information on discard numbers at age for inclusion in fish stock assessment and support scientific research. These programmes have no monitoring or control functions. Sampling levels are generally below 1% of the total fleet effort, and as a result discard estimates can be highly variable. The use of observer data to demonstrate compliance with catch levels has already resulted in observers by default having a monitoring role. If a catch based approach is introduced, this would require a re-definition of the role of 'at-sea' observers and their legal basis. This could have consequences for the collection of biological data, the primary role through gaining access to individual vessels, potential sampling bias. The low level of observer coverage would lead to potentially imprecise estimates of cod discards and this could lead to disagreement in total catch estimates, particularly if these are used as the primary monitoring function in any revised plan. The situation would be further complicated in light of implementation of any proposed discard ban.

6.4.3 Utilising information from stakeholders

The level of compliance with management measures is key to the success of any new regime. Understanding how different stakeholders might react to proposed measures in advance of implementation will aid in the design of measures, and contribute towards maximising compliance. Recent work on regulatory impact assessment of agricultural regulations (Powell, et al, 2011) and other regulatory actions (UK govt Better Regulation Task force, 2011; Macleod, et al, 2006; National Audit Office, 2010 indicates that key reasons for failure of regulations are linked to faulty assumptions about strategic behaviour of those being regulated, and lack of understanding on how stakeholders will react to changes in other external drivers (e.g. fuel prices).

Information on likely behavioural change can be ascertained through relatively small representative sample surveys focused on collecting qualitative data. Sample surveys can be targeted at different segments of fisheries to ascertain the opinions and perceptions of those involved in fishing activities. For example, a proposal to operationalize a ban discards can be explored through discussion with a range of stakeholders as follows:

- Sample of fishermen – level of understanding of the proposed measure, perception of 'fairness' of the measure, difficulties of complying (e.g. increase in investment required, higher level of skills training needed, reduction in income), likely impact on fishing behaviour; other factors influencing fishing activity; synergistic effects.
- Sample of enforcement personnel – level of understanding of the proposed measure, issues associated with enforcement (e.g. capacity, equipment), perceptions on ease of enforcement.
- Sample of fishing industry representatives – level of understanding among wider fishing community, industry perception on 'fairness', other pressures on fishermen (e.g. changes in market prices), pressure for certification.

Building a picture from active fishermen and those involved in implementation can provide indications of the level of difficulty associated with both complying and enforcing a new measure. Validation through reference to representatives from the wider fishing industry can thus provide some indication of likely overall levels of compliance. A carefully designed survey would potentially allow for identification of problems affecting different segments or metiers of target fisheries.

The type of qualitative data suggested here could be incorporated into a social impact assessment survey.

6.4.4 Fisheries management based on Real Time Incentives (RTIs)

The Real Time Incentives (RTI) approach is a simple, integrated, spatiotemporally resolved management approach that provides incentives for "good behaviour". The approach is built round adaptive control of fishing effort in days without the use of catch or landings quotas. Fishers would be given a number of fishing-impact credits, called Real-Time Incentives (RTIs), to spend according to spatiotemporally varying tariffs per fishing day. RTI-quota and tariffs could be based on commercial stock and ecosystem targets; with regards to commercial stock targets the RTI-settings can be linked to any existing Harvest Control Rule. The fisher could choose how to spend his RTIs, e.g. by limited fishing in sensitive areas, or by fishing longer in less sensitive areas. The data used to set the tariffs would be transparent to assist in that choice. The RTI system does not prescribe and forbid, but instead allows individual fishers to fish wherever and whenever they want from within their FTI budget; ecosystem costs are internalized and fishers have to take them into account in their business decisions. We envisage no need for landings or catch quota for the fleets operating under the scheme. The approach could facilitate further devolution of responsibility to industry.

Kraak et al. (ICES CM 2011/P:11) developed the basic principles of the approach, with an illustrative example of how it might work. The intention is to develop it further with input from the stakeholders (bottom-up) concerning the practical details of its implementation. It may be possible to run pilots under Article 13 of the (current) cod management plan. The mixed nature of the demersal fisheries could be accommodated by applying the RTI-scheme to the most restrictive species in the mixed assemblage only (i.e. cod): the RTI-settings would then be based on cod management targets (plus perhaps a few ecosystem considerations). The other species in the mixed-fisheries assemblage would be controlled by the usual TACs and quota (or catch quota for that matter). The advantage of such a system compared to the current situation would be that fishers would no longer be restricted for the sake of cod limitations when trying to fully utilize other species' fishing opportunities (they will be allowed to deploy fishing effort in spatiotemporal units with low cod 'catchability' in a flexible way). Fleets operating under the proposed approach would neither be limited by landings or catch quota, nor by blanket effort restrictions. Instead, individual operators would be allocated a quota of 'fishing credits' or 'RTIs'. An RTI is essentially a flexible effort allocation of 'credit' that can be 'spent' by fishing in a specific area. As long as their RTI-quota (or 'credit') lasts fishers are allowed to catch and land fish.

The basis of the approach is that the area (e.g. the Irish Sea) would be divided up into 'cells' at a high spatial resolution (e.g. 0.3° longitude * 0.2° latitude). Each cell would have a certain (gear-specific) 'cost' applied to fishing in that cell. The costs would be set by managers in terms of the RTI 'credit'. Fishers would then 'pay' these costs in RTIs per fishing day from their individual RTI account, allocated at the start of the management period, (e.g. year). Where managers want to allow higher/lower fishing effort in a particular cell, or group of cells, relative to other cells, they make the cost lower/higher, requiring fishers to pay less/more, which will increase/decrease the number of vessels and/or the amount of time spent fishing in that cell or group of cells. The cost (in RTIs per day) associated with fishing in each of the cells would be shown on colour-coded tariff maps (Fig. 6.4.1).

Using the tariff maps (Fig. 6.4.1), fishermen are then free to fish when and where they like, according to personal choice, as long as their RTI credit lasts; they would not be allowed to exceed their RTI-quota once they have exhausted it. The total amount of RTIs annually available can be set in relation to (internationally or nationally agreed) objectives or targets for fishing mortality rate (or parts thereof if applied to fleet segments) of the stock of interest (in this case: cod).

The cell tariffs would initially be set based on the historical spatial patterns of the 'catchability' of the stock of interest (in this case: cod; Fig. 6.4.2) and other objectives of interest. The tariffs can also be modified by expert biological knowledge (e.g. location of spawning grounds etc.) and/or based on stakeholder input. Additional spatial information about the ecosystem can be built into the tariffs depending on management objectives. For example, sites of interest such as cold water corals, nursery areas, spawning grounds, marine mammal hotspots, could all be included. Cells with very high catchability of the targeted stock could have ‘infinite’ cost [i.e. they would be temporarily closed for fishing, cf. RTCs] for precautionary reasons. Cells could be closed for other reasons as well, e.g. if they were extremely fragile habitats. The rules used to weight the different sources of information to set the tariffs should be transparent and open to stakeholder participation in decision-making.

Fishers fishing with selective gear with respect to the target species would be operating under different tariffs, allowing them to pay lower levels of RTI ‘credits’ in all cells (Fig. 6.4.3).

Tariffs would be updated on a given timescale, e.g. ‘real-time’ (say, weekly; Fig. 6.4.4) by incoming landings/catches per unit effort (lpue/cpue) data. Thus, if landings/catches from particular cells indicate momentarily higher/lower local abundance of cod, the ‘costs’ of fishing in these cells could be increased/decreased to reduce/increase fishing effort in these cells very quickly (i.e. in ‘real time’). An increase in costs in one or more cells would not prevent fishermen from going to sea and operating in cells that have lower costs in terms of RTI ‘credits’. This temporal update could have different timescales for different factors – e.g. ‘real-time’ update for the targeted stock, but annual update for habitat importance, or update when new information becomes available etc. For time-invariant factors there would be no update needed at all. The updating rules should also be transparent and open to participatory decision-making, involving expert opinion and stakeholders.

An essential part of the approach is that through simulations the tariffs can be related to levels of risk of under- and overshooting the various targets or objectives; these risk levels can be set explicitly by managers in a transparent way (reflecting societal choices). The approach is results-based with feedback: if it fails to deliver one or the other aim or objective on a particular time-scale, the tariffs can be adjusted up or down, e.g. at annual timescale.

The approach will mean frequent changes in the ‘costs’ of fishing that vessel operators/owners will have to take into account when planning fishing trips. It will require a high level of monitoring of landings/catch and constant updates to keep track of the impact of fishing effort. Monitoring and compliance is via VMS and e-logbooks (and similar technologies). Implementing such an approach would require a period of time to put into practice. In the examples given in Figures 6.4.1-6.4.4 below, and discussed above, all values are for illustration purposes only.

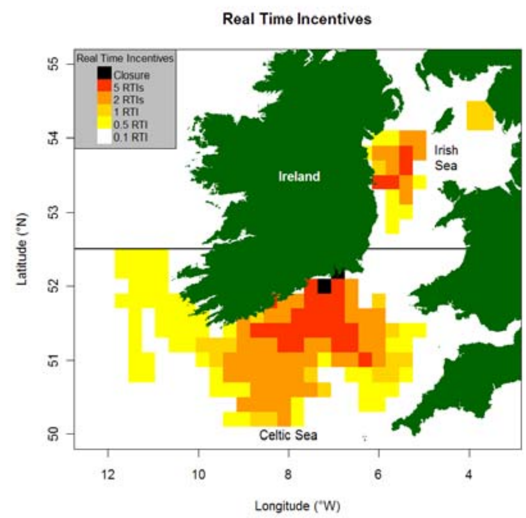


Figure 6.4.1.A so-called 'tariff-map' for the Irish and Celtic Seas. When fishing in a cell a fisherman has to pay (i.e. subtract from his RTI account) a number of RTIs per day according to the colour of the cell. For example, if a fisherman has an annual quota of 150 RTIs, he can choose to fish all the time in red cells and pay 5 RTIs per day, in which case his RTI quota is exhausted and he has to stop fishing after 30 (=150/5) days. Alternatively, he can choose to fish in yellow cells at a cost of 0.5 RTI per day and be allowed to continue 300 (=150/0.5) days. Similarly, fishers can choose to fish in darker/redder cells some of the time and in lighter cells at other times and pay RTIs accordingly.

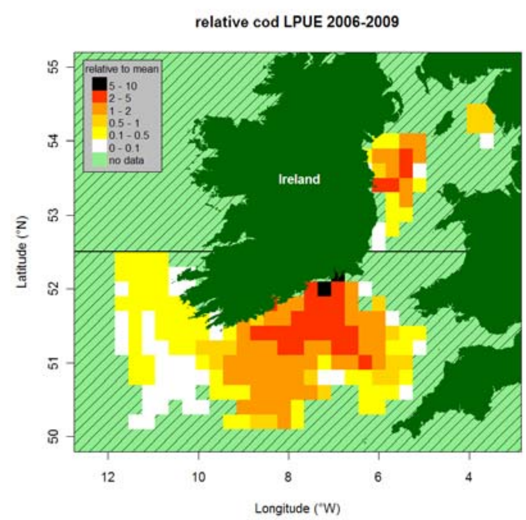


Figure 6.4.2.The tariffs are related to the spatio-temporal cod abundance in such a way that when fishing in white or yellow 'low cost' cells, the catches of cod are likely to be low because these cells had low cod lpue/cpue in the recent past; fishers targeting other species than cod and wishing to avoid cod could fish in these cells without being restricted. On the other hand, fishers could choose and be allowed to target cod by fishing in 'high cost' redder cells where cod catches are likely to be high (based on lpue/cpue in the recent past), but exhaust their RTI quota at a higher pace and having to stop fishing once it is finished. The black cells with the highest recent cod lpue/cpue are temporarily closed (cf. RTCs).

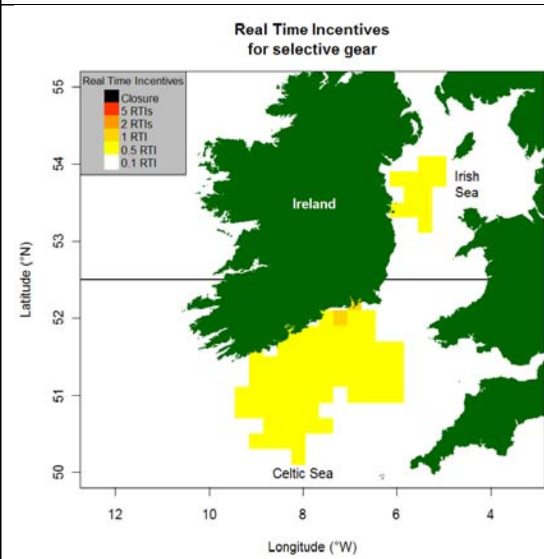
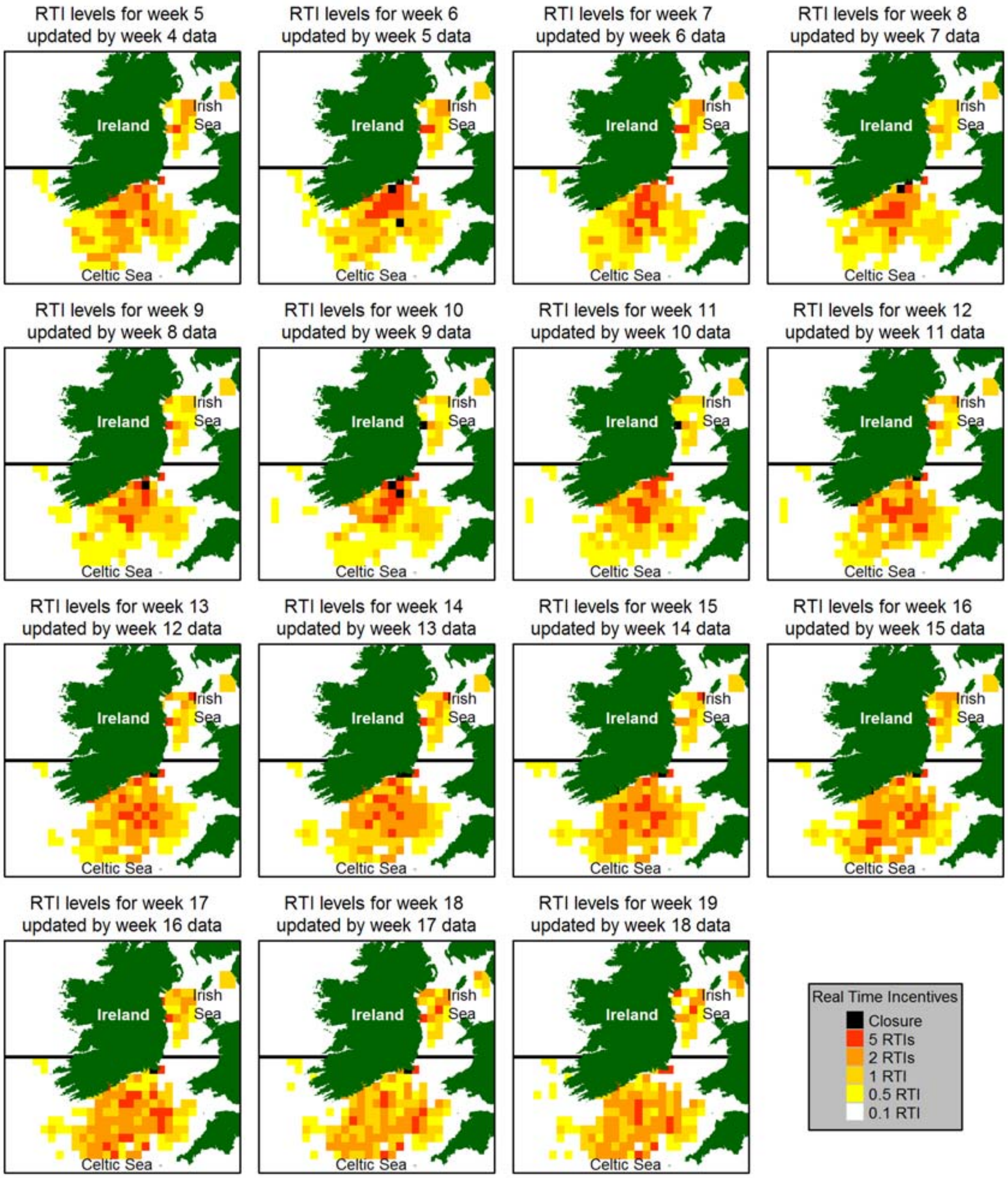


Figure 6.4.3.

Fishers fishing with selective gear, e.g. to which cod vulnerability is 10% compared to standard gear (as demonstrated in scientific studies), would be issued with tariff maps with lower tariffs, i.e. lighter colours. This way they experience no restriction at all in terms of fishing days while they can fish wherever they want (most cells are white or light yellow, where they pay 0.1 or 0.5 RTI per day; thus their quota of 150 RTIs would not be limiting). They are even allowed to fish in cells which are closed to standard gear (at a rate of 1 RTI per day; compare the orange cells with the same cells in Figure 1 where they are black).



ge colour
or higher

6.4.5 Potential use of catch quotas

The evaluation of multi-annual plans for cod in Kattegat, North Sea, Irish Sea and West of Scotland carried out by STECF in July 2011 indicated that landings quotas and effort were unlikely to deliver MSY objectives over the next few years and that landings quotas were unable to restrain catch of cod in these areas. Some consideration should be given to the use of catch quotas, effectively extending some of the derogations under article 11 and 13 to more fully documented fisheries. Such approaches are not yet fully developed but indications are that the following main points describe a system that could contribute to improved management:

- Setting of multispecies targets at European level – agreed by MS
- Operation/implementation for catches at or below target at Regional /MS level.

- MS can choose how to distribute catch, for example main segment, small cooperatives or individual businesses. With or without trading on TACs. Its anticipated that catch allocation/acquisition and fishing decisions set at the business level will deliver the greatest flexibility of response to maximise catch within the limits set. Small groups (cooperatives) may be helpful to give flexibility and for self-policing but only if all members suffer from the misbehaviour of the individual. Allocation at main segment level alone will provide little individual motivation to change.

- This leads to many approaches, three examples are given here
  - Maximum constraint harmonise TACs (catches) using mixed fishery advice at the national segment level. Setting species limits to match.
  - Intermediate constraint implementation would follow the same key but also allow flexibility to increase catches to single species TAC (catches) levels as long all single species TACs (catches) are shown to be respected in year.
  - Full flexibility: TACS set at MSY by species, implementation implies allowing fishers freedom to reconcile the full range of single species TACs themselves provided no TAC (catch) is overshot.
- Responsibility to show compliance with at maximum catches at MS level, with stipulation that catches must be shown not to exceed set limits
  - MS verification of non-compliance can be based on targeting risk based likelihood of over catch.
  - Catch limits maybe restricted to a number of species, eg TAC species.
  - Potential for moderate (10%) banking and borrowing to deal with end of year mismatch without other penalty.
  - MS must show they can either adequately detect non-compliance, or to allocate enough TAC to cover non-compliance.
- Incentives
  - Does not imply reduction of maximum fishing opportunities (mixed fish advice see below) – fishing remains possible as long as TACs on all stocks being exploited are available.
  - Catches need to be allocated / acquired at vessel/business level so incentives are at vessel level
  - Effort restriction are not necessarily needed.
- Requires verification of compliance
  - Low contribution to total catch of cod ‘trips’ – allocated sufficient quota but needing a low level monitoring
  - Major catch ‘trips’ – high level of monitoring (contribution cod quota in particular)
  - Verification of non-compliance can be based on targeting risk based verification.

- Non-compliance must carry sufficiently appropriate 'penalties'. Failure to have appropriate penalties will incentivize non-compliance.
  - May involve specific contracts between licensees and authorities
  - Non-compliance that does not result in excess/inappropriate catch dealt with by minor or negligible penalty except for repeated offences.
  - Non-compliance which results in false/under declaration of catch should be have penalties that reflect probability of detection and magnitude of the potential financial gain detected, including removal of fishing opportunities.
  - Minor over catch that is declared should be dealt with by banking and borrowing, not as an offence.

Much work remains to define these approaches but the key issues are:

- Flexibility for businesses to maximise opportunities
- Reliance on good compliance checks and enforcement to change the culture to one of confidence among businesses that they can operate with confidence their competitors are constrained by the same rules.

6.4.6 Information on mixed fisheries management in other RFMO areas

It is inspiring to get a broad brush overview on how mixed-fisheries issues might be tackled based on information from elsewhere, and some examples the EG was knowledgeable on are illustrated as a comparison.

- Management through "weak-stock" considerations (Hilborn et al., 2004), where protection is afforded to individual stocks, and those stocks with the lowest quotas can markedly influence how an overall fishery is prosecuted, is implemented in New England and in Alaska. US fishers now refer to the stocks having low quotas as "choke" stocks, because once the quota for any of these stocks is reached, then fishing in an area may cease altogether, or restrictive trip limits may be implemented, or other types of controls on fishing may take effect. This corresponds exactly to the "cod" scenario implemented in the Fcube WGMIXFISH advice (Ulrich et al., 2011).
- The Faroe Islands have moved from TAC management to effort-based management in 1995, due to the high overquota discards induced by the TAC. In spite of the relatively small scale and strong local roots of the fisheries and the more limited extent of mixed-fisheries interactions, the system has not proven fully successful in significantly reducing fishing mortality to sustainable levels for the main demersal stocks. There is potentially more resistance against regulating the amount of allowed effort with the same flexibility as with TAC, and average effort has varied by less than 2% per year; but the initial fishing effort was set at a too high level (Jakupsstovu et al., 2007, Baudron et al., 2010).
- In Canada, an interesting example is the case of the community management boards of Nova Scotia (Ulrich and Wilson 2009). This case also addresses complex mixed fisheries allocation issues in the context of overexploited demersal fisheries, multi-level management jurisdictions and strong local dependence of the society on fishing activities. Single-species Quotas are shared by Communities or groups of vessels within a community, and each such group is responsible to manage these internally through local definitions of fleets and fisheries and internal allocation rules. All costs of sharing, managing, observing and reporting are thus internalised within the Community, leading the national governing agency the sole responsibility of setting the overall targets.

- Finally, in New Zealand, the system is entirely based on ITQ, and discarding is banned. The flexibility in the balancing between catch and quota is provided by a carry-over allowance from one year to the next, and the payment of a landing tax, the deemed value, for every fish landed above quota (Marchal et al., 2009).

6.5 Data, research and scientific advice and identified major gaps in the availability of the relevant science.

6.5.1 Biological data and research needs.

There are different levels of complexity dependent on whether the cod stocks, all stocks in the mixed fishery or the whole ecosystem are in the focus of a future management plan. Based on the available knowledge it was decided to focus on the cod stocks, but to take into account mixed fisheries and multi species issues.

Central elements that have to be addressed

- For the impact assessment candidates for MSY targets for given different stock recruitment relationships and time series for recruitment (regime shift) have to be estimated. The impact of HCRs (+ additional management measures as effort management, closed areas, real time closures etc.) on future stock development, F and catch has to be considered. In the estimation of the reference points (i.e., Btrigger, Fmsy) information on historic predation mortalities and density dependent cannibalism should be included where possible. A sensitivity analysis on the impact of changes in weight at age, selectivity patterns as well as dynamics in predation mortalities (and assumptions as well as stomach data behind the estimates) on Fmsy estimates has to be carried out. After the plan is implemented standard single species assessments will allow to annually update stock status, to set TACs and to evaluate progress towards objectives.
- Suitable HCRs have to be developed when there are no accepted assessments.
- As further topic management objectives and trade-offs in a mixed fishery context have to be discussed. This includes an analysis during the impact assessment on what loss of potential yield can be expected if the fishery has to be closed when the first TAC is exhausted or if TACs have to be harmonized beforehand. The impact on the cod stocks and other species in the mixed fishery has to be analyzed. Different implementation strategies (e.g., catch quota system) for a mixed fisheries approach have to be considered during the impact assessment. During the implementation of the plan mixed fisheries assessments have to be carried out regularly. ICES will give mixed fisheries advice on an annual basis based on results from WGMIXFISH.
- According to biological interactions the impact of certain options for the cod management plan on other stocks is a central question. The recovery of a predator stock has its cost as higher predation mortalities will be exerted on prey stocks. The most important links between the cod stocks and its prey species have to be identified. It should be analyzed when the biomass of the cod stocks becomes critical for other species in the food web and the fleets fishing for those other species. Vice versa, it has to be ensured that there is enough prey in the sea to sustain the cod stocks. Once the plan is implemented, regular updates of predation mortality estimates are needed to track changes in the food web to get indications when the status of the food web becomes critical. Currently ICES WGSAM (ICES 2011D) carries out multi species assessments on a regular basis (~every 3 years) but so far for the North Sea only.

Advice needed

The aim of the impact assessment is to find suitable candidate operational biological management targets. Advice is needed on what Fmsy candidate should be used in a new management plan and what has to be included in HCRs and the plan in general to take into account mixed fisheries and multi species issues. In addition, advice on pros and cons of different management measures is needed. Advice is needed on what to do if there are no accepted assessments.

After implementation regular advice is needed on stock status and mixed fishery vs. single stock TACs

Data needed and available

Single species:

- Input and output data from ICES assessment working groups
- Periods (regimes) for S-R relationships to be considered
- Proposals for candidate S-R relationships

Technical interactions:

- Input and output from STECF effort group (landings, discard, effort by fleet). Effort by ICES statistical rectangle.
- Input and output from WGMIXFISH. Only available for the North Sea at present. It is hoped to start mixed fisheries projections for WoS but work on this is unlikely to start until late 2012 at the earliest.

Biological interactions:

- Input and output from WGSAM SMS keyruns for the North Sea (predation mortalities, who eats whom and to what extent).
- Seal diet and abundance data for west of Scotland

Model approaches needed and available

Single species:

A full MSE loop is available for all 4 cod stocks that allows for the evaluation of HCRs under different assumptions on stock-recruitment relationships. It is also possible to take into account bias and uncertainties during the assessment and implementation process.

For standard single species assessments several models are available (B-ADAPT, SAM, TSA etc…)

Technical interactions:

Fcube is available as used by the ICES WGMIXFISH group for the North Sea. Fcube allows for the quantification of catch in the mixed fishery under different management scenarios (e.g. cod as limiting factor).

Biological interactions:

For the North Sea the stochastic multi species model SMS is available. Historic trajectories of predation mortalities on cod can be provided to be included in single species assessment models on a regular basis. It is also possible to establish simple linear relationships between predator biomasses and cannibalistic predation mortalities that can be used in forward simulations in a single species MSE loop (see above). In the forecast mode SMS can be used for scenario testing in a multi species context (i.e. what is the impact on prey stocks if cod and all other species are fished with Fmsy).

For cod west of Scotland it is possible to include information on seal predation in the standard single species assessment model TSA.

No multi species models are sufficiently developed for Kattegat and the Irish Sea cod.

Limitations in data and knowledge

Single species:

There is an accepted assessment for NS cod, though this assessment may be altered in 2012 due to updated natural mortality and improved estimation (better modeling of discards)

Currently no accepted assessments for West of Scotland, Kattegat and Irish Sea cod. Stock status and progress towards objectives (i.e. F based targets) cannot be evaluated properly so far. This may change after benchmarks carried out early 2012.

Technical interactions:

- Discard information not available for all fleets. Gaps have to be filled by using information from other countries/fleets.
- Discard and age information often biased due to non-random sampling or simply too few trips per metier/group.
- Data currently available in STECF or ICES databases are not enough spatially resolved to analyse spatial overlap between fleets – need for landings by ICES statistical rectangle data. This data would allow overviews of the extent of spatial overlap in catches between stocks, e.g. cod and haddock, cod and whiting etc.
- Difficult to predict CPUEs and/or discard rates
- Difficulty to define metiers (how many do we need?)
- Mixed fishery projections from areas other than the North Sea are not available. It is hoped to start mixed fisheries projections for WoS but work on this is unlikely to start until late 2012 at the earliest. The ease of implementing mixed fisheries projections WoS depends to a large extent on the outcome of ICES benchmark meetings. If the VIa cod and VIa whiting assessments are accepted as full quantitative assessments the current mixed fisheries forecasting method (Fcube) can be implemented with limited methodological change. Currently, in addition to West of Scotland there are also no accepted cod assessments for, Kattegat and Irish Sea cod. There are no plans to apply the Fcube model to these areas.

Biological interactions:

- Stomach data to parameterize the North Sea SMS are mainly from 1981 and 1991 (+ some data from 1985-1987). Such old data in combination with structural uncertainties and incomplete process understanding (see points below) can lead to biased results. Data on seal diet is available for west of Scotland but many guestimates needed for other species ➔ No real multi species functional feeding response and dynamics in other prey than cod are ignored so far.

- The North Sea differs in complexity from the Baltic. While the Baltic is a more complex physical environment, it has rather less biological complexity, certainly in terms of finfish diversity

- Other food component not well described in the North Sea SMS (implemented as a constant biomass pool)➔ Some of the dynamics in predator prey relationships may be missed.

- Structural uncertainties in SMS: feeding response, constant spatial overlap assumed etc…

- Hardly any multi species information available for Irish Sea and Kattegat cod

There is a need to use validation to improve the understanding of the modelling. For instance stomach condense could be predicted by the model and then checked against newly collected data.

For the West of Scotland it would be helpful to obtain a third seal diet estimate, and validation of the detection of feeding rates would also be helpful.

6.5.2 Economic data and research needs.

Assessment of Economic Impacts of LTMPs

The starting point for economic impact assessment is the fleet in place at the start of the plan, and its financial condition, at the starting point of the plan. A description of the fleet segments and status of businesses at the start of the plan period will be required.

Biologists indicate that for a non-integrated modelling approach they would assume 100% uptake of the quota every year, and for cod, for up to 10 years, that is not a totally unreasonable assumption. If a non-integrated approach were taken, economists could produce a non-dynamic economic assessment based on different management plan scenarios, showing sensitivities of total revenues to potential catch composition changes. This would have to be a restricted number of years, probably no more than 10.

If a bioeconomic approach is taken (and this would be preferable) there is a model for the North Sea available from the resource rent project called FISHRENT (Salz et al 2011). This model involves 6 (DCF) fleet segments and has been developed at FOI. The Dutch fleets are not included as they only catch around 10% of the total TAC. The model (although the biology is simplistic) should also be used in addition to the biological scenarios to start up discussions about different possible outcomes. Of course more detailed fleet segmentation could be used, although this is labour intensive and does not necessarily change the outcomes.

We recommend therefore that the cod LTMP impact assessment should be conducted under this new framework contract using DCF data for 2008 onwards, and a bio-economic model such as the FISHRENT model. We recommend checking whether FISHRENT can be applied to the Irish Sea and West of Scotland cod stocks and fishing activities.

There are some data gaps or data weaknesses that might need to be addressed or simply taken into consideration in any impact assessment analyses. We recommend that these are considered in detail and responses agreed before any impact assessments are conducted. The data gaps and weaknesses include:

- Fleet segments for economic DCF are rather crudely defined
  - E.g. Demersal trawl includes nephrops trawl
- Only average figures per vessel and segment totals available – can work with this
- Capital values rather shaky so return on is investment unreliable
- Value of fishing rights, quota units, no reliable data, due to non-transparent market
- Price elasticity of demand is not available
- Price differentials for sizes of fish may be partially available
- Poor understanding of indebtedness, retained profits and proximity to business failure
- Poor data on trigger circumstances for removing vessels from targeting certain species, so fleet dynamics unreliable
- Lack of baseline data showing tactical and strategic responses to conservation options and catch quotas making it difficult to assess impact of plans

Proposed Terms of Reference for North Sea, West of Scotland and Irish Sea economic impact assessments of Long Term Management Plans for cod.

Assess likely economic consequences of implementing the various LTMP harvest control options advised by the Commission compared to continuing to fish under current arrangements.

Experts carrying out the assessment are requested to liaise with the stock assessment scientists who prepared the biological scenarios on the compatibility of impact assessment systems.

If possible, make use of an integrated bio-economic simulation modelling approach, using a model such as FISHRENT.

Data for the assessment should either be DCF fleet segment economic variables or similar data sets based on more narrowly-defined fleet segments than are available via DCF data, for example, fleet segments that do not combine white fish trawl and nephrops trawl into one fleet segment.

Specific requests

1. Provide a description of the principle MS fleets which prosecute have recently landed and can be expected to continue fishing for cod caught in Area VIa, Area IVa,b,c and Area VIIa, their recent activity and, as far as possible, their economic outcomes. These should include fleets from Ireland, UK, Denmark, Germany, Netherlands, Belgium and France. These fleet descriptions will highlight the vessels likely to be affected by the management plan.

2. Based on the predicted landings of cod arising from the options advised by the Commission, and based on expected landings of other key species caught by the same vessels that catch cod, estimate for the relevant fleet segments likely future trends in:

   a) the entire landings of the vessels involved. It might be appropriate to make qualitative assessments and comments with regard to likely responses of vessel businesses to reductions in

TACs of these cod stocks, specifically, the extent to which they are likely to exploit other stocks or simply to reduce their overall activity.

b) the value of catches, with appropriate assumptions about prices that can realistically be made given lack of data to suggest specific relationships between volume of landings and sales price achieved. If the predicted landings data includes information on size of fish landed, try to incorporate the influence of fish size on fish sales prices.

c) fishing effort, in terms of vessel numbers, activity and kW deployed

d) costs (both fixed and variable) of expected activity levels

e) employment on board vessels associated with this activity

f) expected cash flow and gross value added (as defined in The 2009 Annual Economic Report on the European Fishing Fleet) of the vessels involved in these fisheries.

g) any expected evolutions in fleet size or capacity that can be determined by the modelling approach utilised

Appropriate assumptions should be made and described regarding the remainder of the fishing opportunities of the vessels involved being held stable for all the options assessed.

Expected trends should be contrasted with the probable consequences of continuing to fish the stock according to rates of fishing mortality as recently experienced, or according to ICES advice.

A 10-year time frame should be used for the evaluations. Detailed modelling outputs might only be appropriate for a shorter time frame, but comparative likely outcomes for the longer term, implying the effects of investment decisions, should be considered qualitatively at least.

6.5.3 Social data and research needs.

Objectives

- Collect baseline data on 'direct social impacts' (i.e. impacts on those actively involved in fishing as discussed in section 6.3)
- Explore reactions to the proposed range of alternatives
  - e.g. increased effort restrictions; removal of effort restrictions; fully documented fishery; ban on discards/landing all catch; stronger links to markets for by-catch; changes to composition rules.
- Identify demands made on fishers, and likely behavioural changes across different vessels/fleets/MS
- Identify implementation issues
- Explore potential for new institutional arrangements (or changes in existing arrangements) that will assist in achieving compliance with new management regime

Work to be done

- Decide on management measures for assessment
- Develop agreed set of indicators for measuring social impacts
- Collect baseline date from existing data sources and sample survey.
- Create Online survey
  - Translation for different MS

  - Support/encouragement from MS fishing organisations to encourage participation of fishermen

- Telephone interview – to validate online survey data
  - small representative sample of fishermen
  - small number of other stakeholders

6.6 The options for revised management plans to be taken forward into the impact assessments

6.6.1 Amendments to existing plan

Some articles are unclear, ambiguous and have led to differences in interpretation and application of the current plan across MS. There is a need to reconsider the key elements of article 13, remove the ambiguity and potentially abandon some e.g. the 5% clause which creates a perverse incentive to increase catch of other species in order to maintain compliance with the percentage threshold. Removing ambiguity in the existing regulation could be best achieved by providing detailed implementation guidelines. This should include details on i) how to interpret the article (with worked examples), ii) what data is required (burden of proof concepts), iii) how this data will be evaluated. STECF (PLEN-09-01) called for the formation of a dedicated expert group to develop such guidelines and to analyses and provide comment on the effectiveness of cod avoidance plans, building further on the criteria and methods already developed by STECF and some Member States. Such a WG would also develop ideas on how to quantify the amount of buyback effort with regards to the various cod avoidance behaviour (e.g. selective gear, effort displacement). This recommendation still stands. Under the current article, STECF is only requested to provide comment on some elements. STECF could be used to provide advice on all aspects of article 13.

The current approach requires that MS can demonstrate the overall fleet cod avoidance measures in terms of changes in fishing mortality. This approach is too complex and is reliant on final year mortality estimates from analytical assessments. The final year estimate is often uncertain and in the case of IS/WoS/Kat, the assessment is highly uncertain and should not /cannot be used to evaluate changes in fishing mortality associated with cod avoidance measures. Further, if there is a desire to evaluate the effectiveness of the actions of individual businesses, then an alternative metric is required. The metric needs to be responsive to the pressure that is being monitored and ideally be easier to understand and control. If catches are possible to account with enough precision by implementing a fully documented fisheries monitoring system, it would be a better indicator of changes in fishing mortality than effort. In such case the implementation of adequate compliance measures would reward businesses by undershooting their catches and penalise overshooting.

6.6.2 Alternative incentives

The principles of article 13 are sound; it encourages individual businesses to avoid catching cod, the fundamental objective of the plan. In return for cod avoidance, businesses are incentivised by additional fishing effort. This key element has resulted in significant changes in fishing behaviour and has incentivised good practice. If effort management is no longer considered as a necessary element of a future plan, this would effectively remove incentivization of good behaviour. The resulting changes in fishing pattern has additional benefits species other than cod, the use of species selective gears for example in Nephrops fisheries, has also led to significant reductions in discards and by-catches of other species. The distribution of recouped effort under the provisions of article 13 provides the current basis of incentivising participation in cod avoidance programmes. Individual businesses will balance the perceived costs of participation against the cost benefit of additional effort in return. In this sense, effort has become a currency. In the event that a catch based approach is introduced in a future revision of the plan, where the cod outtake is effectively monitored and controlled, this could potentially at least, remove the need for effort adjustment as a tool to enact changes in fishing mortality. If this occurs, it removes the effort currency that is used at present to provide incentives to participate in cod avoidance programmes. It may be worthwhile giving consideration to alternative incentive mechanisms to encourage participation that are not necessarily reliant on additional allocation of effort fishing opportunities. Alternatives could revolve around increased quota allocations for other species. A review of incentivising tools used in other fisheries will be undertaken.

Under the current approach, there is significant risk of a free rider effect that could potentially penalise the 'good' behaviour of individual business because inaction by others in the fleet means that the cumulative effects in terms of cod catch reduction have not received desired levels. In such case, the individuals who act in an appropriate manner to reduce cod catches are penalised in two ways. Firstly, cod avoidance whether achieved through avoiding areas of higher cod abundance or the use of more selective gears are likely to reduce revenue from other species, lowering their revenue return in contrast to other vessels who do not undertake cod avoidance. Secondly, if the relative reduction in cod catches is greater at the individual business level than the relative reduction at the MS level and this triggers effort reductions at the MS level, the compliant vessels have not only reduced catching efficiency through cod avoidance but they are also subject to future effort reductions because of inactivity of other vessels. In this context, it would be desirable that the incentives to avoid catching cod are internalised at a business level and that the penalties for not contributing are also internalised at the individual level. There may also be potential to incentivise a not just individuals but a small group of vessels acting in cooperation. Achieving this will help avoid the free rider effect outlined above.

Following the concept of internalisation of incentives and costs at a business level would also be necessary to internalise data provision i.e. reversing the burden of proof to the individual business. Individuals could be required to provide information on the individual catch and effort opportunity under which they operate so that their cod avoidance behaviour can be properly evaluated, since it is not possible for scientists to get this information as such a detailed level.

6.6.3 MSE (KAT NS, IS, WoS cod)

Summary

MSE simulations considering the current management plan regime have been conducted (STECF 11-07 report), but these need to be repeated to consider the following aspects:

<u>Management regimes</u>:

Several management regimes are possible (e.g. current regime, catch quota regime, discard ban, mixed fisheries approach, multi-species approach, etc.). Within the current evaluation framework and time frame available for the work, only a subset of these can be evaluated (current regime, catch quota regime), but implication of some of the others in terms of implementation error could also be investigated.

<u>Implementation error</u>:

The MSEs conducted for STECF 11-07 considered full compliance and non-compliance (for NS cod F reduced by an amount of 3% per annum (matching observation), and for IS and WoS cod F remained unchanged, in all cases regardless of the F intended by the management plan). Implementation error thought possible under alternative management regimes could also be considered. Then for NS cod, a comparison of estimated F from the most recent assessment and intended F by the management plan is proposed to form the basis of the range of implementation error considered thus giving some indication of the utility of the management approach. The approach chosen is to test a range of implementation error scenarios to be assigned to errors expected under different regimes based on analysis/expert option.

Revised operating models:

Changes to the assessment models of all three cod stocks (NS, IS, WoS) are possible in the coming months (changes foreseen by WKCOD in 2011 for NS to be reviewed and potentially updated by WGNSSK (ICES 2011B) in April/May 2012, and a benchmark meeting planned in February 2012 for IS and WoS). Depending on the outcome of this work, the operating models may need to be revised to account for the changes. It is possible that the WoS TSA assessment will include a seal sub-model, and it is proposed that this be handled as before in the MSE analyses (refitting the data with B-adapt), but accounting for mortality imposed by seals as an additional component of natural mortality.

Recruitment:
In the past the approach taken when conducting an MSE for the three cod stocks (NS, IS, WoS) was to consider two stock-recruit scenarios: the "standard recruitment" scenario fitted a Ricker curve to all the available stock-recruit pairs, and the "low recruitment" scenario simply halved the alpha parameter so that the stock-recruit curve was consistent with the recent period of low recruitments evident for all these cod stocks

Maturity:
The maturity ogive for all three cod stocks considered here is year-invariant.

Weights at age:

The weights should taken as mean for last 3 years for all three cod stocks:

HCR:

The HCRs considered depend on whether there is an accepted assessment or not (i.e. whether the assessment is used as a basis for providing catch forecasts). This in turn depends on the outcome of the forthcoming benchmark and working group meetings. In the case where there is an accepted assessment, it is proposed that the HCR from the current management plan, with variations in TAC constraints, be evaluated. In the case where there is no accepted assessment, it is proposed that HCRs based on a biomass index be considered (e.g. taking a proportion of the biomass index, where the proportion is consistent with an appropriate level of exploitation – may need objective in this case – e.g. increase stock by x% in 2015). The timescale for impact assessment simulations should be a minimum of 10 years

As a contingency the plans should contain a clause indicating how management will be conducted if no assessment is available. The evaluate possibilities other methods of setting TACS will need to be investigated.

Objectives:

The performance of a management plan HCR should be evaluated according to it's probability of meeting pre-specified objectives.

Quantifiable targets with time frames, e.g.

- Probability of fishing at F_{MSY} by 2015
- Probability of being below some SSB threshold level (Bpa / Blim /Bloss by year)
- Stability of catches in a 10-year period
- Final SSB

Current reference levels are as follows (these may need to be re-evaluated following changes in the assessment models):

The reference points associated with each of the cod stocks:

	Kattegat	North Sea	West of Scotland	Irish Sea
B_{pa}	10500	150000	22000	10000
B_{lim}	6400	70000	14000	6000
F_{msylo}		0.16	0.17	0.25
F_{msy}		0.19	0.19	0.40
F_{msyhi}		0.42	0.33	0.54

<u>Operating model</u>

General

- Stock-recruit curves: form (Ricker, Beverton-Holt, etc) and level (whole period, recent low period only)
- Bayesian meta-analysis to include different function forms to reduce number of scenarios considered and give exploitation range for high catch
- Unallocated mortality
  - Bias in catch: assuming that unallocated removals from the stock are a consequence of fishing, for example through discarding practices that are not sufficiently represented in the discard sampling
  - Bias in M: assuming that unallocated removals from the stock are a consequence of additional sources of natural mortality.
- Dynamic modelling of unallocated mortality (may be linked to implementation error for bias in catch, or to density-dependence in M for bias in M). Consider also doing this based on realized Fs and intended management plan Fs.

Stock specific

- NS - Alternative M scenarios (e.g. new key run)
  - Density-dependence in M
- WoS - Include seals? May be enough to do through M.
- IS - Need to account for bycatch even when TAC set to zero

HCR

Depends on status of assessment.

- Catch forecast available: existing HCR
- No catch forecast: use trends-based HCR (need to know objectives of plan as it will influence the form the HCR takes).

Compliance

Need to explore sensitivity of HCR performance to different levels of implementation error (based on assumptions about implementation of plan). Its likely that these will be modelled as a range of failure to reduce F from continued exploitation at status quo F to achievement of the full F reduction required.

Options for revised management plans to be taken forward into the impact assessments

Quota management

Alternatives are:

1. the current approach (TAC=landings),
2. a catch quota system (TAC=landings + discards),
3. a discard ban (TAC=landings + discards, but with different implementation error consequences compared to the catch quota system)
4. mixed fishery approach (with alternative rules for TAC management)
5. a multispecies approach

Realistically, only the first two can be directly evaluated within the existing MSE simulation framework, including investigating sensitivity to TAC constraints, with options for implementation error scenarios considered to illustrate the outcomes for the remainder.

Effort management

It is not possible to consider an effort-only based management system because of the requirements for relative stability among EU nations, so it is anticipated some form of quota management will still apply. Although this option cannot be explicitly considered in the existing simulation framework, it may be possible investigate implementation error scenarios for combined effort-quota management system See section 6.4.4.).

Area closures

A considerable amount of work has already been done on evaluating the effectiveness of area closures in the North Sea and of real time closures under the Scottish conservation credit scheme.

In 2001, the European Commission implemented an emergency closure of a large area of the North Sea from 14 February to 30 April (EC 259/2001). An EU-Norway expert group in 2003 concluded that the emergency closure had an insignificant effect upon the spawning potential for cod in 2001. There were several reasons for the lack of impact. The redistribution of the fishery, especially along the edges of the box, coupled to the increases in proportional landings from January and February appear to have been able to negate the potential benefits of the box. The conclusion from this study was that the box would have to be extended in both space and time to be more effective. This emergency measure has not been adopted after 2001. A cod protection area was implemented in 2004 (EC 2287/2003 and its amendments), which defined conditions under which certain stocks, including haddock, could be caught in Community waters, but this was only in force in 2004.

Scotland implemented in February 2008 a national scheme known as the 'Conservation Credits Scheme'. The principle of this two-part scheme involves additional time at sea in return for the adoption of measures which aim to reduce mortality on cod and lead to a reduction in discard numbers. Cod discarding rates in Scotland have decreased from 62% in the scheme's initial year of operation (2008) to 36% in 2010. In 2010 there were 165 closures, and from July 2010 the area of each closure increased (from 50 square nautical miles to 225 square nautical miles). Recent work tracking Scottish vessels in 2009 has concluded that vessels did indeed move from areas of higher to lower cod concentration following real-time closures during the first and third quarters; there was no significant effect during the second and fourth quarters (Needle and Catarino 2011).

In order to consider the impact of an area closure scheme it would be necessary to estimate the F reduction associated with the closure regime and or any change in selection due to a change in availability due to the closure.

6.7 Work plan for the work necessary to evaluate the potential impacts of these options.

Topic	Description of work	Lead person(s) information required/ availability – time scale for work
Descriptions of main segments	• Description of main patterns by fleet / metier / mesh size wrt. species composition etc • Obtain catch and effort data for all effort groups from EFFORT data base • Investigation of the consistency between ICES landings by stock and STECF landings by fleet/metier in West of Scotland, and provision of a mixed-fisheries dataset • Description of the technical interactions in WoS at a fine spatio-temporal scale by gear / fleet • National examples of such equivalent based on	Norman / Clara Steve (benchmark?) Nick / MSS? Clara (Francois), Norman – England, Scotland? Ernesto / JRC

	coupling VMS/logbooks for other areas • Investigation for the requirements to collect landings by rectangle in the next effort data call	
Implications of Mixed fisheries advice	• Common North Sea data call ICES WGNSSK (ICES 2011B) / WGMIXFISH for 2011 data • North Sea Mixed-Fisheries Advice for 2013 • Trial run of mixed-fisheries advice for WoS • Update of the MIXFISH economic data time series by fleet • Coupling of Fcube with a MSE by stock (continuation of 2009 AFRAME Work) • Trail runs of some mixed-fisheries MSE • The introduction of economic considerations into the MSE model above cannot be ascertained !!	Steve / Clara, March 2012 ICES WGMIXFISH ; May 2012 Steve /Clara (depending of data above) Ernesto / Clara (March 2012) Clara (May 2012) Clara in communication with José (May 2012) Clara / any goodwill economist
Mixed fish advice WoS IS/Kat	To be discussed at March meeting	Norman/Eskild to bring discussion papers IS/KAT Steve to update on WoS
NS Assessment	There are two areas of development with the North Sea cod assessment that are up for discussion at the forthcoming WGNSSK (ICES 2011B) meeting (27 April – 3 May 2012), and will affect the way any impact assessment for a North Sea cod management plan is conducted. Changes to multispecies M A key run of the SMS model was recently performed (WGSAM), and derived revised estimates of M for North Sea cod. These estimates are somewhat different from the previous key run, due to the combination of incorporating seal and harbour porpoise consumption, incorporating sprat as an additional dynamic prey species and changing the statistical distribution used for stomach data (from lognormal to Dirichlet). These revised estimates have implications for North Sea cod productivity, and would need to be accounted for in the MSE if found to be appropriate by WGNSSK (ICES 2011B). Change in assessment model structure At a benchmark meeting for North Sea cod in early 2011 (WKCOD), the current SAM assessment model	ICES WGNSSK (ICES 2011B)

	was accepted, but with caveats. The following quote is taken from the WKCOD report: *"SAM was adopted by the workshop as a basis for assessments for an interim period (~two years), while additional analyses are carried out with the aim of providing a more suitable long-term solution. Although the SAM model structure agreed at the workshop is considered the most appropriate that could be fitted in the time available, a refined model structure will only be completed with further work. Consequently, if further refinements are found to be required before the WGNSSK 2011 meeting, they should be presented to that meeting for adoption (WGNSSK comprises a large part of WKCOD participants). In the medium term WKCOD considered that the development of a model structure that models discard and landings separately is required due to the differing levels of noise associated with each data set."* Further progress has now been made and presented at the WGMG meeting in 2011, and it is envisaged that further refinements will be made and presented to the WGNSSK 2012 meeting for adoption. If accepted, the refined NS cod SAM model should be used as the basis for further MSE work.	
WoS Assessment	West of Scotland cod assessment will be the subject of a Benchmark 22-29 Feburary 2012. This may potentially change the management options so work on Impact Assessment cannot start until this complete and it has either ben accepted or rejected Incorporation of grey seal predation into the single species stock assessment. This and other revisions will be considered at an ICES benchmark assessment (WKROUND). The aim is for an accepted assessment that can partition mortality into fishing mortality and natural mortality that experiences trend (i.e. natural mortality not accounted for by the constant value used traditionally). That would allow clauses within a management plan (revised or existing) that rely on a quantitative value for F to be invoked. If an assessment with seal predation is accepted parameter values established for the seal feeding model to be passed to CEFAS for inclusion in MSE after WGCSE (ICES 2011C). WKROUND will also host a benchmark for WoS whiting. The focus of the work will be on reconciling biomass trends	Steven Holmes: WKBENCH scheduled for 22-29 February 2012. It is recommended the types of control measure appropriate for WoS be considered once it is known whether full quantitative assessments for WoS cod and whiting have been established. The first stock assessments using revised methodology are conducted at ICES WGCSE in May 2012.

	resulting from catch data and survey abundance indices.	
IS Assessment	Irish Sea cod assessment will be the subject of a Benchmark. This may potentially change the management options so work on Impact Assessment cannot start until this complete and it has either been accepted or rejected	Chris/Rob WKBENCH scheduled for 22-29 February 2012.
Multi species interactions Sensitivity analysis	North SEA:	
	1. Use cod M2 values from the SMS keyrun 2011 to be able to update single species assessment for North Sea cod	Time scale: available Morten/Alex
	2. Analyse simple relationships between cod biomass and M2 to be able to take into account cannibalism in single species MSE and estimation of Fmsy and other reference points.	Time scale to provide simple relationships: end of January; MSE + reference point analysis later! Jose. Single species MSE Morten/Alex: Reference point analysis
	3. Test the sensitivity of M2 estimates and simple relationships towards different error distributions for stomach content observations and stomach content data sets. Provide different sets of M2 values and simple relationships for further testing the sensitivity of Fmsy and other reference points.	Time scale: end of February Alex/Morten Circulate John Jose
	4. Run SMS in forecast mode using single species Fmsy values and detect likely conflicts between single species management plans under different assumptions on stock recruitment regimes.	Time scale: end of April Alex/Morten
	West of Scotland:	
	1. Implement seal predation in standard single species assessment model TSA. Fit the predation sub-model to seal diet data under different assumptions on the underlying processes, i.e. different seal feeding models (M2 dependent on cod abundance or not)	By conclusion of ICES WKROUND; end of Feb 2012
	2. Make assumptions on future seal abundance and using parameter values from the chosen seal feeding model (from step 1) incorporate seal predation inside a MSE loop. Amending existing MSE in CEFAS	Time scale: Early June 2012
Spatial / Technical decopling	Working paper on possibilities for WG	Norman / Margit
Conventional/multispecies MSY targets	Comparison of MNSY targets across stocks using Bayes meta analysis, including differences in regime, growth, maturation, natural mortality, and SR functions.	John S / Jose / Morten supply assessment and natural mortality information.
MSE	See detailed discussion in the text above	José De Oliveira

Enforcement For 4 cod and Baltic – put in both sections	Survey for control agencies and scientific community in the relevant MS to collect: • Control and infringement data (number of controls and infringements by type of enforcement tool if possible and management measure). • Compliance estimations (%) per management measures. • Average cost per control and type of enforcement tool. Ranking of management measures bases on expected compliance. Litterateur study on non-monetary incentives?? Norman/John	Jenny – before the next meeting. Jenny plus others
Stakeholder survey	**Main tasks:** 1. Decide on management measures for assessment 2. Explore existing literature and develop agreed set of indicators for measuring social impacts. 3. Collect baseline date from existing data sources and sample survey. Analyse 4. Create Online survey 4.1 Translation of instrument for different MS (and translation of responses) 4.2 Survey available on-line 4.3 Support/encouragement from MS fishing 4.4 Organisations to encourage participation of fishermen 5. Telephone interview 5.1 Design interview schedule 5.2 Identify samples 5.3 Collect data from small representative sample of fishermen 5.4 Collect data small number of other stakeholders 6. Data analysis and report writing **Timing of the study.** ***March*** Baseline indicator information (employment/salary) can be delivered by March using existing sources of data. On-line survey – time frame very tight. On-line survey will require translation into 2 or 3 other languages and must be available on-line for at least 4 weeks, preferably 6 weeks. Unlikely to have a survey instrument ready until late January.	Lead person: John Powell Support from other Researchers in CCRI Information required: Task 1: agreed set of management measures to explore Task 3: Using existing EU data on employment and salaries. Task 4: support from national fishing organisations to encourage participation in on-line survey. Translation work. Task 5: names/phone contact details of representative samples of fishermen and stakeholders Time scale for work: Task 1: 1 week Task 2: 2 weeks Task 3: 1 week Task 4: 8 – 12 weeks Task 5: 2 weeks (run during task 4) Task 6: 2 weeks

	Unlikely to have agreement/contract until early January (at earliest). Previous experience suggests significant time required to chase up and encourage fishermen to take part in survey. Telephone interviews can be undertaken during period that on-line survey is available to save time. **It will be very difficult to deliver this survey by March due to amount of time needed to encourage response to survey.** If information on behavioural response to proposed measures is to be included, there must be agreement on measures to explore before the survey instrument is designed. ***June*** - easier to collect data in this time frame - More opportunity to expand number of respondents and ensure representation from different MS and different metier. **Key timing issues:** - Amount of time to undertake translation (this will be minimised through careful design of questions to maximise tick box approach). - Level of support from national associations to encourage fishermen to take part in survey. - Time required to allow all fishermen to be informed/complete survey.	
Article 13 evaluation		Norman
Detecting non compliance	If catch quotas are to be considered it may be necessary for all vessels to report data on catch and size range of species caught. It would be helpful to define a minimum set of data that could potentially be used to estimate levels of catch dumping / discarding. Comparison of data from observed and non-observed trips. Using observer trips can we draw out what parameters should be collected from and compared between observed and non-observed trips to evaluate compliance with catch quotas.	Eskild, Norman/Nick
Economic evaluation	Carry out a study investigating potential economic objectives and constraints including the Disproportionate cost approach in relation to long term management plans for cod.	To be proposed as Framework project.

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Annex A Framework for Impact Assessments Report

The following layout describes the minimum aspects to be considered in preparing an Impact Assessment. In addition the meeting should consult the Table in Appendix I which details a more complete list of relevant questions for impact assessments, where appropriate additional aspects should be added.

1. Problem statement

The Commission should provide scope and limits of problem to be addressed

Why there is a need to react and where appropriate link this to background studies or information.

2. Define objectives : general / specific / operational

General objective: will be CFP (statement provided by the Commission)

Specific objective: what the objectives are in terms of changes and expectations of outcomes with timescales (for example achieving exploitation target in X years)

3. Identify tactical methods

Describe the operational objectives (which may be option dependent)

Effort changes / or Capacity / or TACs with interannual stability criteria.

Select the different approaches that are to be considered.

These should be predefined by Commission and limited to a specified range confirmed at the scoping meeting.

4. Overriding considerations of the Options

Identify if there are significant parts of the any options that are unlikely contribute to the overall objectives

Identify if in the opinion of the evaluators the options are likely to be able to deliver the objectives of the plan.

5. Environmental Effects of the Options

5.1. Evaluation of the effects of the multi-annual plan options on the fishery

Show what is expected to be the resulting impact on landings and the fleet of any of the following aspects that are affected by the plan options:-

• Catch and effort limitations – either through TAC or effort management expected to result from the different options.

• Technical measures – eg. Closed areas, gear restrictions, etc. that are included in the options.

• Control and enforcement measures proposed – eg. Entry and exit rules, allocation rights, etc. and any exemptions,

• Capacity management measures that are included in the options,

What is the expected fishery response to the different options? The response strategies of the fleets include possible shifts to other stocks or species, to other gears or métiers, changes in discard and slippage and other behavioural issues.

5.2. Evaluation of the effects of the options on the stock

This section should be adapted to any particular plan and stock.

a) Evaluating the stock response to the changes in the fisheries resulting from the plan - will the options deliver their own internal objectives with respect to the stock?

b) Evaluating whether the values of target and other reference points referred to in the plan are consistent with current knowledge and the objective of achieving MSY by 2015.

• Are the reference points in the plan appropriate given the current information on stock status and dynamics?

• Are the options likely to achieve F_{MSY} by 2015? If not, why? (see note 1)

• Are the options likely to be considered precautionary. If not, why? (see note 2)

• Is there a need to propose all the measures in the plan to make it capable of achieving the objectives? If so is STECF able to propose simpler options for a better plan to achieve stock – specific objectives?

5.3. Evaluation of the effects of the multi-annual plan on the ecosystem.

• What impacts of the different options plan on the ecosystem can be identified? Ecosystem impacts might include changes in discarding practices, by-catch rates, and catch of non-target species, habitat degradation, etc.

• What will be the effect on agreed indicators or descriptors that are directly (and where possible indirectly) affected by the options.

6. SOCIAL AND ECONOMIC EFFECTS OF THE PLAN

6.1. Data and Calculation of Indicators

• If there is no explicit socio-economic objectives defined by the multi-annual plan the options should be measured against the general socio-economic objectives as stated in the CFP.

• Will the explicit socio-economic objective defined by the multi-annual plan be met by the different options.

• The social and economic state of the fleets exploiting the stock or stocks concerned can be assessed using appropriate indicators, i.e. those proposed in the plan or those given below which include those proposed by STECF in the April 2009 plenary report.

Yearly economic indicators

- *Value of landings* ~ revenue from sale of fish.

- *Market price* ~ ex-vessel price and where possible price along the chain.

- *Gross Cash flow* ~ income minus all operational costs (excluding capital costs).

- *Break even revenue* ~ long term break even revenue. The income (revenue) level at which economic profit is zero.

- *Gross Profit* ~ income minus all costs, including capital costs.

- *Gross Value added* ~ contribution to gross national product (GNP). Income minus all expenses except capital costs and crew cost.

- *Fleet size and composition and value*

- *Return to be shared* - (share of owner (incl. vessel) and crew after paying the running costs) Turnover - landings costs – fuel costs – food costs – bait costs – ice costs (can be calculated from DCF data)

It is important to identify which indicators are appropriate for the specific cases being assessed as it is unlikely that all of these will be available or appropriate in all cases. The scoping meeting should identify specify economic criteria to allow a comparison between different plans. Once economic criteria for evaluation are selected, the appropriate methodology and data should be specified. The scoping meeting should identify additional data and models that might be required to evaluate the effects of the plan.

Longer term economic indicators over the period of the impact assessment should be obtained from cost benefit analysis.

- Net present value

Social indicators

- *Employment (and in other fishery sectors)*

- Salary ~ if data is available (in the future)to compare with other sectors (job market)

7. COST EFFECTIVENESS OF CONTROL AND ENFORCEMENT

Do the different options have important differences in implementation costs against there effectiveness in delivering the objectives of the plan. (for example is one option able to deliver better conservation measures than another at comparable costs, or do both options has similar conservation properties with differing costs). There is currently no general methodology to provide a quantitative cost/benefit analysis of control and enforcement, however, if there are important aspects to be considered these should be described qualitatively.

8. CONCLUSIONS TO THE IMPACT ASSESSMENT

8.1. Comparison of Options

• based on agreed criteria and draw-up a short-list of options that satisfy the Commissions Objectives for further discussion (Always include option « No Change»)

• Provide a summary table of options

•Screen possible options to see which can best meet the objectives using the agreed the criteria from the scoping meeting to be used to compare the options.

8.2. Effectiveness: best placed to achieve the objectives (select appropriately just to relate to the objectives given above)

• What would be the short and long term impacts for the stock(s) and fleets and linked economic sectors affected by the different options. Will the tactical objectives of the plan be achieved?

• What would be the short and long term impacts of the multi-annual plan on the environment and the ecosystem, for example by-catch, discards, non-target species?

• Are there any likely side effects that might result from the plan? (for example, changes in behaviour that affect other fisheries, or environmental consequences, changes in the market).

• Has the implementation been affected by external factors such as global change, ecosystems effects, or other fisheries?

8.3. Efficiency: cost-effectiveness

• What will be the impact of this plan in terms of for example employment, gross revenue of the fleet?

• Will there be any effects on the broader industry (processing, transporting, auxiliary)?

• What are the expected economic benefit/loss during the period of implementation?

8.4. Consistency: limiting trade-offs across the economic, social and environmental domains

• Are there important tradeoffs between the three main objectives of the CFP (economic, social and environment) that are importantly different amongst the options.

• Are is there any overriding major imbalances among the three main objectives of sustainable economic, social and environmental aspects.

8.5. Forward look to Evaluation

• Define a set of appropriate indicators to measure implementation, compliance, effectiveness, costs and other impacts.

• Plan for future evaluation or review of the policy initiative (when, by whom, what, how?)

Notes:-

1) Achieving targets (F_{msy})– means with 50% probability of achieving this by specified time

2) Precautionary approach criteria in agreement with ICES criteria (95% SSB>Blim) (95% F<Flim)

9 List of Background Documents

Background documents are published on the meeting's web site on: http://stecf.jrc.ec.europa.eu/meetings/2011

List of background documents:

1. EWG-11-15 – Doc 1 - Declarations of invited and JRC experts.
2. EWG-11-15 – Doc 2 - Anderson, J., Jardim, E. and Mosqueira, I. Exploratory data analysis of prices of first sale for Cod, Sprat and Herring in the Baltic Sea. JRC Technical Note n. 67842. 47 p.

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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.

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Abstract

This document forms a report of work in progress of STECF EWG 11-15 which met in Edinburgh for scoping the preparation of Impact Assessments for new management plans. The EWG prepared for work on the following groups of stocks: a) Impact Assessments for a new plan for cod, herring, sprat (and flounder) in the Baltic Sea. b) Impact Assessments for new plans for cod in the Kattegat, North Sea, West of Scotland and the Irish Sea. For NS and consideration has been given to other demersal stocks. For WoS, IS and Kattegat more work is required to extend the cod advice to mixed species fisheries.

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As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

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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.

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