Draft Report in response to the Commission request (DG MARE C2/A2) for:

REVIEW OF SCIENTIFIC ADVICE: TECHNICAL MEASURES in the Celtic Seas (WoS, IS, CS)

Contents

1 ToR1. Appropriate Gear Measures to reduce Dicsards

*STECF is asked to provide, were possible, **gear specifications** in accordance with stock advice from ICES and STECF that would result in considerably less fish of **haddock** and **whiting** in VIa and VIIa; and of **plaice** in VIIa and VII fg being captured (and subsequently discarded), using available information from modified gear in use or which has been tested, either in the relevant fisheries or in fisheries with similar patterns in other areas; STECF is kindly requested to identify the metier(s) (gear/area) for which the gear specification is being recommended, according to high catches of the species by that metier;*

1.1 Introduction

To provide guidance on measures that would result in considerably less whiting, haddock and plaice being retained in ICES Sub-Divisions VIa, VIIa and VIIfg, several approaches have been taken. A review of results from recent and pertinent experiments is reported. We provide a brief summary of the gear modifications tested and the results, and where available, these are contrasted with the current legal technical requirements for the area and fishery. Based on this review and the request to provide specific gear specifications for each area and fishery a number of possible options are presented.

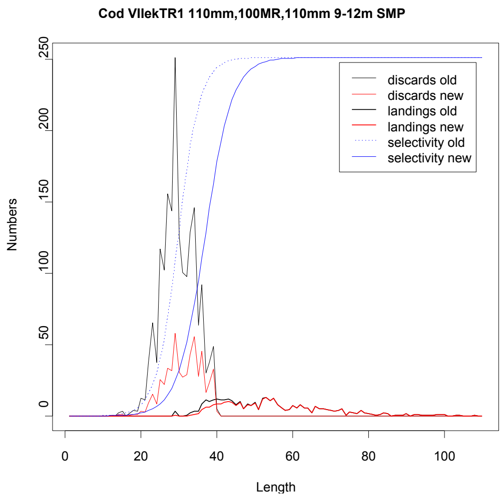
To estimate the potential impact that these options may have had on landings and discards, by weight and number; sampling data of the length frequency (LF) of landings and discards from 2010 were obtained from some member states and for some species. Due to time constraints it was not possible to obtain catch at length data from all countries engaged in the various fisheries and therefore it has not been possible to provide hind-cast simulations for all cases. However, it is considered that there is sufficient information to provide comment on the potential impact that new technical measure may have in the key fisheries where haddock, whiting and plaice are discarded. In all cases, the length data confirms that for all three species, discarding during 2010 was very high.

Where LF data was available, the approach adopted by STECF (PLEN-10-03) has been used where appropriate. These simulations provide a deterministic estimate of what the catch composition would have been if a different (more selective) gear had been used during 2010. As the results are population dependent, it is not possible to model the impact that new measures would have had during 2011 nor into 2012. The simulations should be simply used as guidance as to the magnitudes of change that could be expected. To model the potential impact of introducing a more selective gear, it is necessary to have estimates of the selectivity of the gears currently in use ($S_{current}$), an estimate of the proposed more selective gear (S_{new}) and an estimate of the retained catches at length ($Cn@L_{2010}$) . Hence the catch numbers at length that would have resulted from a change in gear selectivity can be estimated as follows

$$Cn@L_{predicted} = Cn@L_{2010} * S_{new} / S_{current}$$

Weight at lengths estimates were applied to the number of fish retained (landed and discarded) at each length class to estimate the difference in weights retained for each species to provide an estimate of the change in catch weights that would have occurred if the particular gear modification had been used.

Where available, plots are given that show the potential impact that improved selectivity would have had on 2010 catches. The figure below, based on Celtic Sea, is used as an example. This shows the selection ogive of the existing gears (‘*selection old*’) and the selectivity ogive of a gear with improved selection properties (‘*selection new*’). The catch, broken into landings and discards, as estimated from 2010 observer programmes, is shown (‘*landings old; discards old*’). This shows the length structure of landings and discards. From the example shown here, it is clear that the vast majority of the 2010 catch was discarded, with only a small proportion of the overall catch being landed.



We then show the potential impact that improving the selectivity would have had on the numbers of fish caught if the improved selectivity **had been applied during 2010**. There is clearly a marked reduction in discards (‘*discards new*’) with only a small reduction in landings (‘*landings new*’) of cod between 35 and 40cm.

This data is also presented in tabular form. All the fisheries identified are mixed in that several species are caught together. Using selectivity and the length data for other species taken in the fishery, the percentage changes that would have had occurred are presented. This is broken down into the percentage change in landings and discards by both weight and number. Using the table shown below, the effect of improving the selectivity in the otter trawl fishery targeting cod, haddock and whiting in the Celtic Sea can be seen. For cod, haddock and whiting there is a marked reduction in discards in number (70%, 83% and 61%) and weight (65%, 78% and 59%) respectively. The impact on landings weights (the metric of interest from a commercial perspective) is limited for cod and haddock (3% and 13%) but it considerable for whiting (46%). This example clearly shows the trade-offs that are required when adjusting the selectivity in any fishery.

	Cod	Haddock	Whiting
Reduction discards numbers	70%	83%	61%
Reduction landings numbers	12%	25%	52%
Reduction discards weight	65%	78%	59%
Reduction landings weight	3%	13%	46%

The Commission identified a long list of fleets/metiers operating in ICES Sub-Divisions VIa, VIIa and VIIfg. For the majority of these fleets there is little or no area specific selectivity data or data relating to key species, this is particularly problematic for plaice. Given the general paucity of appropriate data, three different ways have been used to estimate the selectivity characteristics of the gears under consideration.

Selectivity estimates (S_{new} and $S_{current}$) for haddock, cod and whiting in otter trawls have been calculated from a selectivity model based on data from the North Sea (Anon, 2002). This model is able to provide estimates based on a range of technical attributes of the gear including codend mesh size, twine thickness, codend circumference, the influence of a lifting bag and the effect of inserting a square-mesh panel of different mesh sizes and locations (relative to the codline). Using this approach, the modelled selectivity for each of the minimum technical specifications for each of the fisheries listed (for otter trawl only) by the Commission is given (Table 1.1). For categories where there is a range of options e.g. 80-99 mm; 5 mm single or 8 mm double twine etc., the modelled maximum and minimum L50 is provided for cod, haddock and whiting. Further details regarding this model and its validation are contained in Annex 1.

For selectivity estimates of fish in otter trawls using grids we use catch comparison trials where the control gear is the same as the gear being currently used and the test gear is that being proposed. The relative catch rate determined from these trials is then equal to S_{new} /$S_{current}$, and the new catch at length can be calculated directly. There is however a lack of selectivity data for the smaller fish (~ <18 cm) so we discuss possible outcomes based on a review of the literature.

For beam trawls there is very limited selectivity data available and none from the ICES Sub-Divisions specified in the request. To provide selectivity estimates for the current gear and to offer an assessment of the likely impact associated with changes in mesh size, mean selection factors (SF = L50/mesh size) derived from beam trawl experiments conducted in the North Sea were used. This simple description of selectivity assumes that the L50 is linearly related to mesh size and does not depend on any other gear parameters (L50 = SF*mesh size). We also assume a constant selection range.

We must be cautious when applying these models, especially when selectivity is close to zero (i.e. for the smaller length classes). Predictions of catch of the smaller length classes will be highly dependent on the estimates of the relative catch rate S_{new} /$S_{current}$ and could lead to large under/over estimates of catch. In order to reduce the likelihood of this happening we have only compared like with like; by this we mean we have used selectivity estimates that (i) have been predicted using the same model or (ii) have been calculated from the same set of experimental trials.

Table 1. Summary output from selectivity model showing the estimated minimum and maximum selectivity for the current technical measures in force by area and metier.

Area	Gear Group	Fishery Description	Haddock				Whiting				Cod			
			L50		SR		L50		SR		L50		SR	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
VIa (restricted)	TR2	*Nephrops*	21.0	23.5	2.9	3.2	24.4	27.3	7.0	7.8	23.5	26.3	5.0	5.6
	TR1 (<15m)	Mixed demersal	30.9	31.4	5.0	5.4	35.9	36.5	10.3	10.4	34.5	35.1	7.3	7.5
	TR1 (>15m)	Mixed demersal	35.7	36.1	5.7	6.1	41.5	41.9	11.9	12.0	39.9	40.4	8.5	8.6
VIa (outside)	TR2 (70 -79mm) [1]	*Nephrops*	14.4	18.1	2.2	3.1	16.7	21.0	4.8	6.0	16.1	20.2	3.4	4.3
	TR2 (80-99mm) [2]	*Nephrops*/Mixed	17.0	25.1	2.9	4.6	19.8	29.2	5.6	8.3	19.0	28.1	4.0	6.0
	TR1 (100-109mm) [3]	Mixed demersal	24.6	28.4	4.3	5.3	28.6	33.0	8.2	9.4	27.5	31.8	5.8	6.7
	TR1 (110 - 119mm)	Mixed demersal	28.0	31.7	5.0	6.0	32.5	36.8	9.3	10.5	31.3	35.4	6.6	7.5
	TR1 (120mm+)	Mixed demersal	31.3	32.1	5.7	6.7	36.4	37.3	10.4	10.7	35.0	35.9	7.4	7.6
VIIa	TR2	*Nephrops* (70 - 79mm)	16.5	19.9	2.9	3.6	19.2	23.1	5.5	6.6	18.4	22.2	3.9	4.7
	TR2	*Nephrops* (80 -99)	19.0	24.7	3.6	5.1	22.1	28.7	6.3	8.2	21.2	27.6	4.5	5.9
	TR1 (OTB/SSC)	Mixed /target demersal	26.3	26.6	5.0	5.1	30.6	30.9	8.7	8.8	29.4	29.7	6.2	6.3
	BT2	Mixed flatfish	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VIIb-k	TR2 (70-79mm) [4]	*Nephrops*	14.7	17.9	2.9	3.6	17.1	20.8	4.9	5.9	16.4	20.0	3.5	4.2
	TR2 (80-99mm)	*Nephrops*	18.0	24.6	3.6	5.1	20.9	28.6	6.0	8.2	20.1	27.5	4.3	5.8
	TR2 (90-99mm)	Mixed demersal	23.0	26.3	4.3	5.1	26.7	30.6	7.6	8.7	25.7	29.4	5.5	6.2
	TR1 (100mm)	Mixed demersal	26.3	26.6	5.0	5.1	30.6	30.9	8.7	8.8	29.4	29.7	6.2	6.3

[1] Where the panel in *Nephrops* trawls is specified based on the 5 mesh rule an assumed position of 15 - 18m and 12-15m have been taken for the purpose of modelling.

[2] Wide range due to change in MR limits between 80-89 and 90-99.

[3] Where panel position is not specified other than under 850/98 the assumption is that the panel is situated 12_15 (max selectivity) or 15-18m from the codline.

[4] Outside hake box.

1.2 Summary conclusions by area, species and metier

1.2.1 ICES Sub-Division VIa – TR2 *Nephrops* – Haddock and Whiting

Haddock recruitment in 2009 (0-gp) is the highest recorded in the past 9 years which has resulted in high discard rates of 1-gp fish in 2010, particularly in the TR2 fleet. ICES estimates the total catch (landings + discards) to be 5830 t, where the demersal fish fleet (TR1) contributes 3217 t (2861 t landed, 356 t discarded) and the *Nephrops* fleet (TR2) 2613 t (21 t landed, 2592 t discarded) therefore accounting for 51% of the catch, while only accounting for 0.7% of the landings. ICES recommends that the selection pattern should be improved in the *Nephrops* (TR2) fleet to reduce its high proportion of discards. 2010 recruitment is estimated to be of a similar magnitude to that of the 2009 year class.

Whiting recruitment has been poor in recent years although ICES notes that there are indications that recruitment has increased in 2010. The TR2 fleet accounts for 62% of the total catch, of which 99% is discarded. ICES recommends that the selection pattern should be improved in the *Nephrops* (TR2) fleet.

In addition to discarding of haddock and whiting, it is estimated that the TR2 fleet account for approximately 21% of the total cod catch in VIa (300 t) of which 140 t is discarded. While this is low in comparison to the TR1 fleet (~1000 t catch, 88% discarded), it still represents a significant source of mortality. The spawning stock biomass is considered to be still well below Blim, but continues to grow from an all-time low in 2006. The 2005 and 2008 year classes are comparable with the long term geometric mean and are the highest since 1997. Based on precautionary considerations, ICES advises that the catches should be reduced to the lowest possible level.

The high discarding of haddock during 2010 associated with the TR2 fleet is a consequence of the relatively strong 2009 year class. The discard at length data associated with the UK TR2 fleet has a modal length of ~18 cm, the modal length of the 2009 year class in 2012 (3-gp) could be expected to be around 30 cm (Figure 1.2.1). While any moderate changes in the *size* selection pattern associated with changes in square-mesh panel mesh size or position or increases in mesh size will offer protection to any future recruitment, it is unlikely that these will offer any further substantive protection to the 2009 year class, which by 2012 will probably contribute more to landings rather than discards as the majority of the 2009 cohort will be above minimum landing size. If the objective is to allow the 2009 year class to contribute to the spawning stock (ToR 4), then measure that exclude haddock in the TR2 fleet are required (*species* selectivity).

The 2010 recruitment estimates for VIa haddock indicate that the 2010 year class is of similar magnitude to the 2009 year class (Figure 1.2.2). Given the low stock status (spawning stock biomass) shown in Figure 1.2.2, in order to rebuild the haddock stock in VIa, which is estimated to be at its lowest level in the time series, allowing the 2009 year class to contribute by reducing the catches associated with the TR2 fleet is likely to be highly beneficial. **In summary, given the discarding associated with the 2009 year class observed during 2010, improvements in both the size selectivity (to protect the 2010 year class) and improvements in species selectivity, to allow the 2009 year class to contribute to the spawning stock biomass, are warranted as a matter of urgency.**

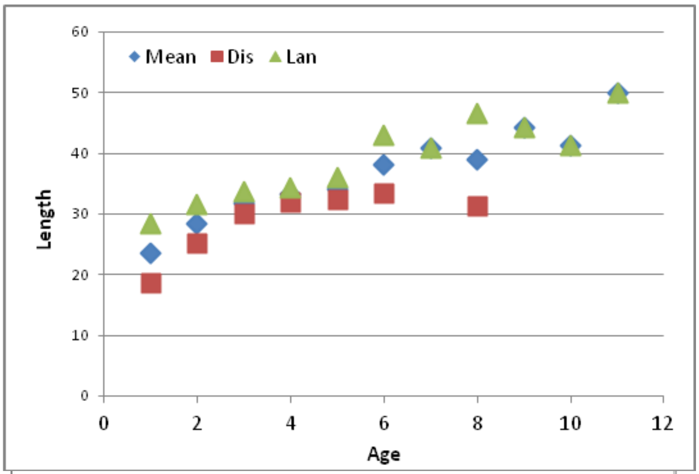


Figure 1.2.1. VIa haddock mean length at age.

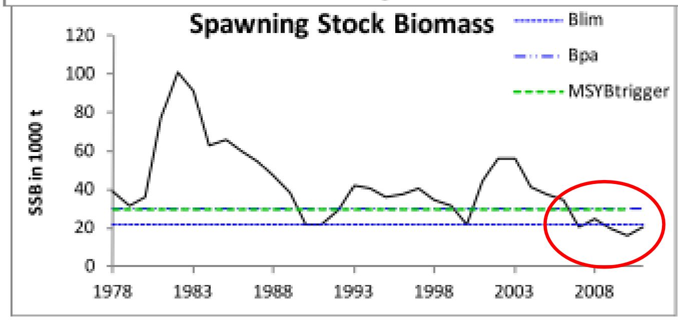


Figure 1.2.2. Summary of recruitment and spawning stock biomass estimates for Haddock in ICES Sub-Division VIa. The 2009 and 2010 recruitment estimates (above) and the recent trends in SSB (bottom) are highlighted.

1.2.1.1 Current Technical Measure in force

Emergency measures introduced under EC regulation 43/2009, requires vessels targeting *Nephrops* (>30% of landings) to use an 80 mm codend, with at most 120 meshes in circumference, and a square-mesh panel of 120 mm located 9-12 m from the cod-line. The selectivity model described above estimates that codends with these design specification have an L50 of ~27 cm. Such codends will have offered protection to the 2009 year class as 0-gp and 1-gp fish (during 2009 and 2010). Nevertheless the discard levels in 2010 were very high which suggests that the selectivity of the current gear is lower than that estimated by the selectivity model. This may indicate (i) that there are difficulties implementing the technical measures; (ii) the model, which is largely parameterised from selectivity data obtained from larger mesh sizes, may overestimate the selectivity of codends with mesh sizes in the range 80–100 mm; and/or (iii) it is due to the inherent between haul variability which our analysis does not take into account. Hence we must be careful that the changes in catch composition presented in Table 2 are not over interpreted.

1.2.1.2 Potential technical changes to the VIa TR2 (Nephrops) fishery

It is likely that much of the 2009 haddock year-class is fully selected in the fishery, and is now likely (and certainly in 2012) to be contributing to landings. Notwithstanding, there is benefit in improving the selectivity of the TR2 fleet further as this will benefit any future recruitment (i.e. the 2010 year class which is estimated to be of similar magnitude to the 2009 year class) and reduce catches of whiting, almost all of which are currently discarded.

The haddock selectivity of the TR2 fleet can be improved in a number of ways. For instance, the selectivity model of annex 1 predicts that (i) a 10 mm increase in mesh size would increase L50 by ~3.3 cm, (ii) a reduction of ten meshes in circumference would increase it by ~ 0.8 cm, (iii) a decrease in twine thickness of 1 mm (for double twine) would increase it by ~1.2 cm and (iv) the removal of the lifting bag would increase it by ~ 2.7 cm. Furthermore many studies have shown that the performance of square-mesh panels improves the closer they are fitted to the codline and as their mesh size increases (Hillis et al., 1991; Arkley, 1993; Briggs and Robertson, 1993; Robertson and Shanks, 1994; FRS, 2002).

Ideally it would be desirable to improve the selectivity of haddock and other discarded species without any reduction of *Nephrops* catches. A meta-analysis of the results of over 40 *Nephrops* selectivity data sets (from a range of European countries) was carried out by the ICES Working Group on *Nephrops* Selection (WKNEPSEL) which met in Aberdeen, February 2007 (ICES, 2007). The working group identified that mesh size, mesh shape and the presence/absence of a lifting bag have a significant effect on *Nephrops* selection. Over the mesh size range 80 – 100 mm this model only predicts an increase of ~1.7 mm in the 50% retention carapace length. This relatively small shift in selectivity is supported by recent trials on Scottish commercial vessels which were unable to find a difference in the *Nephrops* selectivity of 80 and 95 mm codends (Kynoch et al., 2008).

There are very few directed studies on the influence of the number of meshes in circumference or the effect of a lifting bag on *Nephrops* selectivity. Larsvik and Ulmestrand (1992) suggested that the number of meshes in circumference may impact *Nephrops* selection and limited studies carried by Briggs (1981; 1983) showed no difference in the size distribution of *Nephrops* caught by nets with and without lifting bags. Both these studies are based on a limited data and are inconclusive. The Working Group did not find a dependence on the number of meshes in circumference but found that removing the lifting bag could lead to large increases of the *Nephrops* 50% retention length.

Hence a possible codend design change that would improve haddock selectivity and minimise losses of *Nephrops* would be to change the existing position of the 120 mm square-mesh panel from the current position of 9 to 12 m from the codline to 6 to 9 m, increase the codend mesh size to 95 mm and reduce the number of meshes in circumference from 120 to 100. The model of Annex 1 predicts that this would give a haddock L50 of ~32 cm and the above analysis suggests it would have little effect on *Nephrops* catches. Figure 1.2.3 shows the predicted impact on haddock, whiting and cod catches (landings and discards) that would have occurred if the gear configuration described above had been used. Table 1.2.1 contains the modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used.

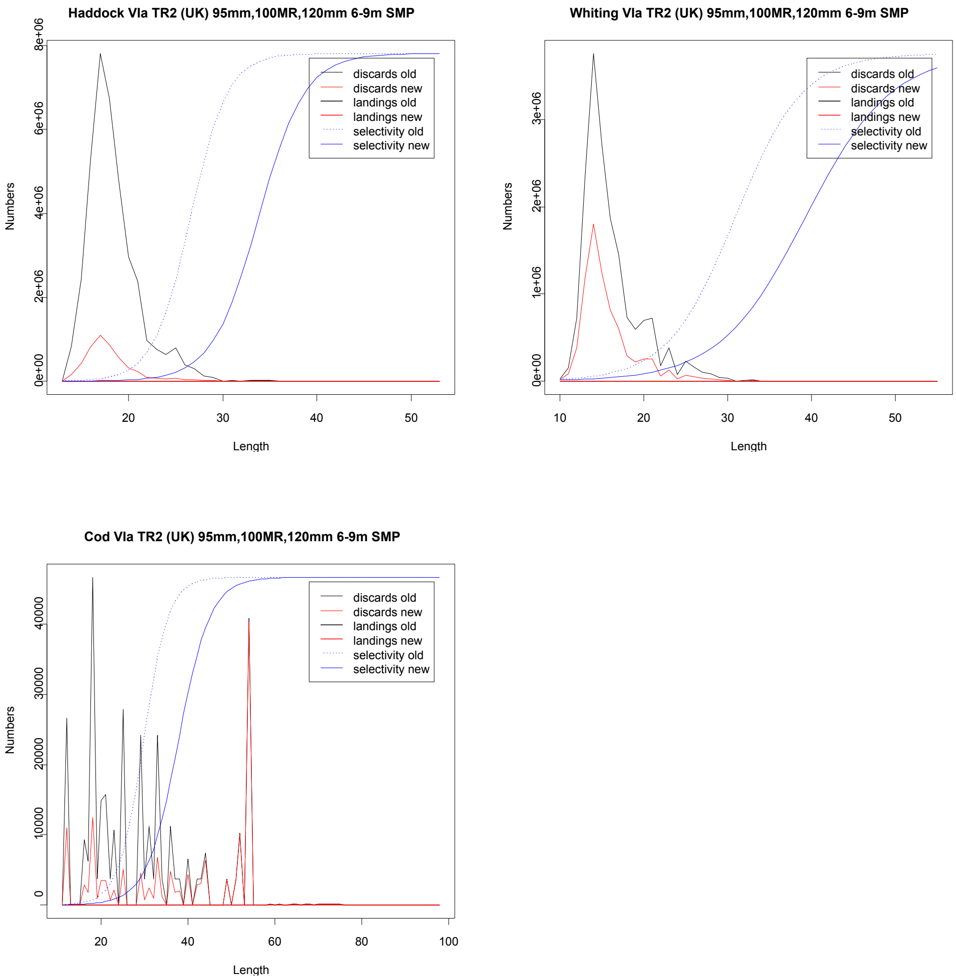


Figure 1.2.3. Simulated effect on haddock, whiting and cod catches (2010 population) of increasing the codend mesh size from 80 to 95 mm adjusting the position of the square-mesh panel from 9-12 m to 6-9 m from the codline and reducing the number of meshes in circumference from 120 to 100 in the VIa TR2 (SCO) fleet.

	Haddock	Whiting	Cod
Reduction discards numbers	87%	56%	57%
Reduction landings numbers	48%	42%	2%
Reduction discards weight	88%	60%	24%
Reduction landings weight	45%	36%	0%

Table 1.2.1. Modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used in TR2/VIa (i.e. 95/120 mm, 100 MR, 6-9 m SMP, and 4 mm double twine codend).

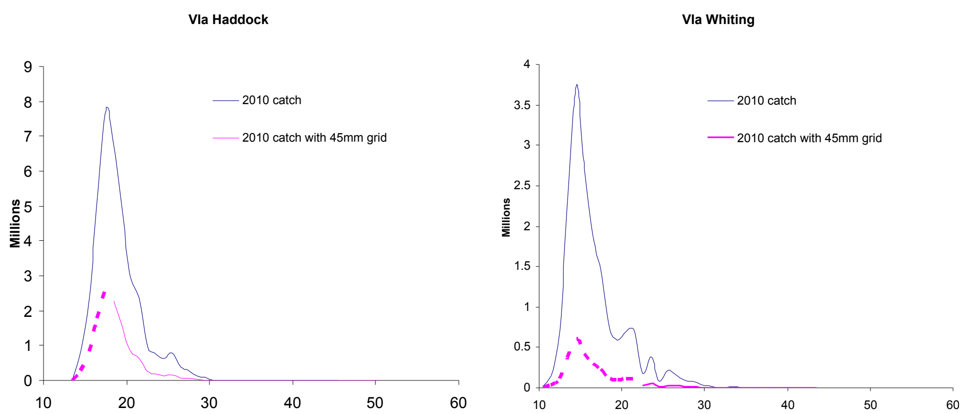
Given the currently low spawning stock biomass of cod, haddock and whiting in VIa, it may also be desirable to reduce all catches of these species, including fish above minimum landings size, associated with the TR2 fishery. This, if done in conjunction with methods to improve the size selectivity of smaller individuals, would maximise the contribution the 2009 and 2010 year classes would make to the spawning stock biomass. ICES (WGCSE, 2011) notes that the introduction of sorting/Swedish grids should also be considered as a management option to reduce discards.

The Swedish grid is a development of the Nordmore grid that has been modified to select for fish in *Nephrops* trawls. The principle is that the grid blocks the path to the codend, fish are deflected above the grid though an escape hole and out of the gear whereas *Nephrops* can pass between the grid bars into the codend. A number of studies of the selective performance of the Swedish grid have been published (Ulmestrand and Valentinsson, 2003; Catchpole et al., 2006; Drewery et al., 2010) all of which demonstrate the ability of the grid to exclude larger fish of all species from the codend, for example, in trials with a grid with a 45mm bar spacing no cod > 46 cm, haddock > 50 cm, whiting > 42 cm were retained in the codend (Drewery et al., 2011). The selectivity of the grid in relation to smaller length classes (~ < 20 cm) is less well understood.

Catchpole et al. (2006) found that a gear fitted with a 35 mm Swedish grid caught more small haddock and cod than a standard gear. In most other trials fish this size were not encountered so it is difficult to generalise this result. Criticisms of the grids by the industry include handling difficulties and blocking. Recent trials have begun to investigate flexible grids, which are lighter and fit more easily around net drums (Loaec et al., 2006; Drewery et al., 2011).

Here we examine the effect of introducing a 45 mm flexible Swedish grid based on the results of trials carried out in Scotland (Drewery et al., 2011). Figure 1.2.4 shows the predicted impact on haddock, whiting and cod catches (landings and discards) that would have occurred if the gear configuration described above had been used. Table 1.2.2 contains the modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used. Clearly, there is a very large reduction in discards, but almost all fish that would otherwise have been landed are excluded.

There are of course other gear modifications, such as increasing the mesh size of the square-mesh panel, coverless trawls, low headline trawls which should also be considered. Bova et al. (2009), Kynoch et al. (2008) and Madsen, et al, (2010) have investigated the selective performance of codends with square-mesh panels of mesh sizes up to 300 mm which have been shown to reduce catches of cod, haddock and whiting. There are a number of reports on coverless and low headline trawls (Dunlin and Reece; 2003; Revill et al, 2006; Kynoch et al., 2010) which suggest that these types of modifications may reduce catches of larger haddock and whiting but may not be effective for cod or smaller haddock or whiting. A full review, however, of these and other modifications are beyond the scope of this report.



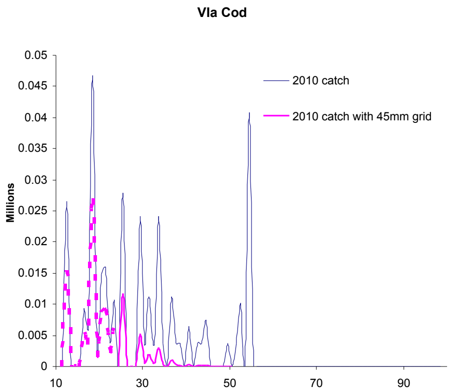


Figure 1.2.4. Simulated effect on haddock, whiting and cod catches (2010 population) of the inclusion of a 45 mm grid inserted in an *Nephrops* trawl with an 80 mm codend and a 120 mm square-mesh panel inserted 12-15 m from the codline in the VIa TR2 (SCO) fleet. Note that the dashed line is an extrapolation of the selectivity data due to the absence of fish within this range during the selectivity trials.

	Haddock	Whiting	Cod
Reduction discards numbers	69%	84%	68%
Reduction landings numbers	90%	95%	100%
Reduction discard weights	71%	85%	92%
Reduction landings weights	90%	96%	100%

Table 1.2.2. Modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used in TR2/VIa (i.e. a 45 mm flexi-grid, with an 80 mm cod-end and a square-mesh panel inserted 12-15 m from the codline).

1.2.1.3 ICES Sub-Division VIIa, TR2 Nephrops – Haddock and Whiting

ICES (2011) notes that "an increase in mesh size to reduce discarding will be beneficial to this stock (haddock) and could increase future yield. Improved selectivity on younger ages would reduce discarding and promote stock increase when strong year classes occur. Recruitment of haddock in 2010 is uncertain and there are conflicting signals from the surveys. ICES (2011) notes that the catches of whiting in VIIa are uncertain, but considers that majority of catches are discarded, with approximate estimates of 100 t landed and in excess of 1000 t discarded. ICES (2010) notes that further management measures should be introduced in the Irish Sea to reduce discarding of small whiting in order to maximize their contribution to future yield and SSB. For cod, ICES advises that based on MSY considerations that catches of cod in VIIa should be zero. With the exception of the 2009 year class, cod recruitment has been very low. ICES further notes that by-catches including discards of cod in all fisheries in Division VIIa should be reduced to the lowest possible level and uptake of further technical measures to reduce discards encouraged. Both cod (Figure 1.2.5) and whiting stocks (Figure1.2.6) in the Irish Sea are at historically low levels. While the haddock biomass has seen a marked decline in recent years (Figure 1.2.7) and effort should be made to allow any recruitment to help rebuild the biomass. The majority of the fishing mortality for both species is attributed to the TR2 *Nephrops* directed fishery. Given the very low spawning stock biomass for these species, it is important that fishing mortality is reduced as much as possible to rebuild both stocks. This requires not only the protection of incoming recruitment, no matter how weak, and minimising the capture of all fish currently in the population. Therefore the priority for VIIa should be to improve both the size selectivity to reduce discarding of small haddock and whiting and the species selectivity of *Nephrops* trawls to avoid the capture of all cod. This requires changes to the current technical measures to improve their size selectivity and the need to introduce measures such as the Swedish Grid to minimise cod catches.

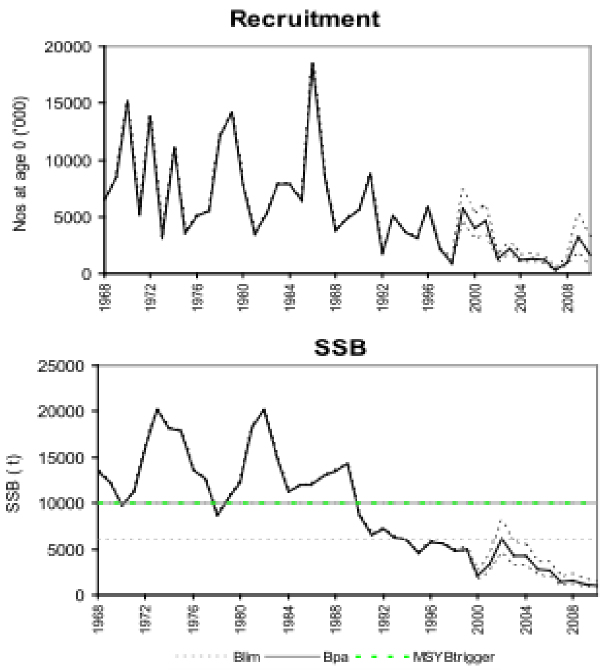


Figure 1.2.5. Recruitment and spawning stock biomass of cod in the Irish Sea (left hand panels) and whiting (right hand panels) (source ICES 2011).

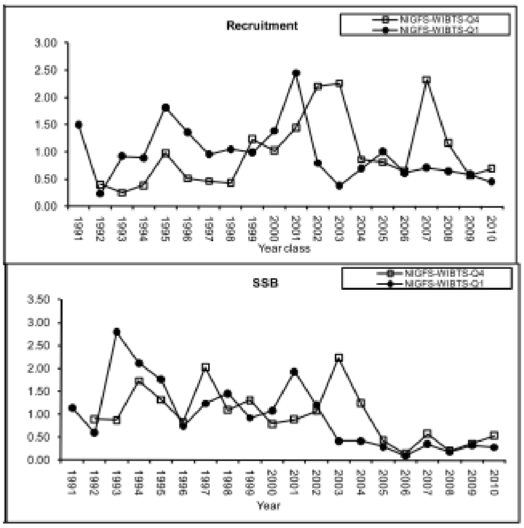


Figure 1.2.6 . Relative estimates of recruitment (top panel) and spawning stock biomass (bottom panel) for Irish Sea whiting.

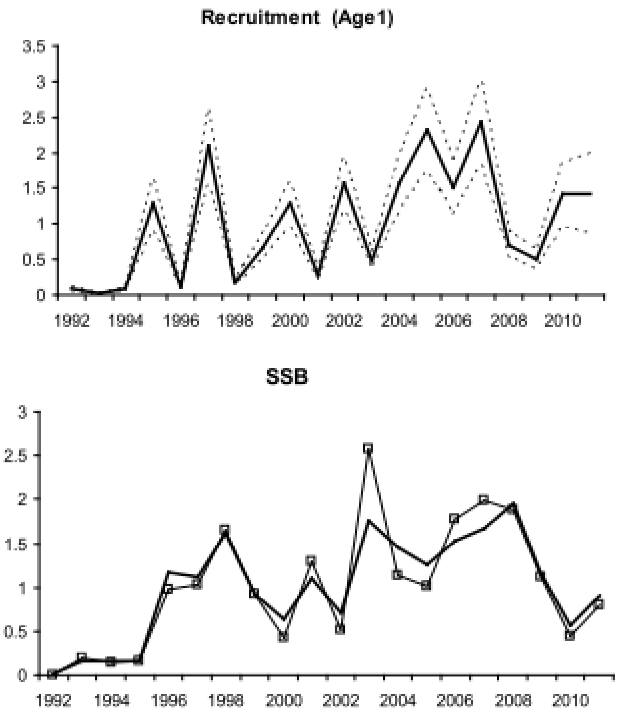


Figure 1.2.7. Relative estimates of recruitment (top panel) and spawning stock biomass (bottom panel) for Irish Sea haddock.

1.2.1.4 Current Technical Measures in force

Vessels targeting *Nephrops* are required to fit an 80 mm square-mesh panel. Unlike the requirements in VIa, where a 120 mm panel is required inserted 9-12 m from the codline, the positioning of the panel in VIIa is defined where the anterior of the panel must be no more than 5 meshes from the selvedge. This can result in positioning of the panel in the tapered section of the trawl and without any information available as to the length of the extensions used in the fishery, it is not possible to estimate with any certainty what the selectivity of the gear is in practice. Standardization of legislation might be necessary in order to have coherent regulation with other fisheries/areas. Notwithstanding, for the purposes of providing guidance as to the likely impact that changes in selectivity may have had if more selective gear had been used in 2010 the 80 mm panel was assumed to be positioned 12-15 m from the codline. Some fleets are using 80 mm mesh to target *Nephrops*, 90 mm mesh in mixed fisheries and 100+ mm to target gadoids and other species.

1.2.1.5 Potential technical modifications for the TR2 fleet operating in VIIa

The haddock and whiting size selectivity of the gears used by the TR2 fleet fishing in VIIa must be improved in order to reduce discarding, to protect future recruitment to the stock and to maximise their contribution to SSB. Such an improvement could be achieved by increasing the mesh size of the square-mesh panel to at least 120 mm and positioning the panel at 3-6 m from the codline, given the very short extension length used and to increase the mesh size (e.g. 95mm) in the codend to help improve size selection of small fish. In order to improve the selection of small fish, there is also a need to improve the selectivity of the cod end, e.g. by increasing the mesh size or reducing the numbers of meshes in circumference. Figure 1.2.8 show the predicted impact on haddock, whiting and cod catches (landings and discards) that would have occurred if the gear configuration described above had been used. Table 1.2.3 contains the modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used.

There are also a number of other measures that have been shown to improve selectivity such as the square-mesh panels positioned at the fishing circle or between the fishing circle and the taper in the short, low headline nets used in the Northern Irish fishery (Briggs, 2010; Armstrong et al., 1998). While the results of these trials are promising and reduced discards of juvenile haddock and whiting with no loss of *Nephrops*, catches were low and it is unclear how they perform for cod. To minimise the capture of cod it will be necessary to introduce a grid type device in conjunction with improvements to the size selectivity of the codend. A number of studies of the selective performance of the Swedish grid have been published (Ulmestrand and Valentinsson, 2003; Catchpole et al., 2006; Drewery et al., 2010) all of which demonstrate the ability of the grid to exclude larger fish of all species from the codend, for example, in trials with a grid with a 45 mm bar spacing no cod > 46 cm, haddock > 50 cm, whiting > 42 cm were retained in the codend (Drewery et al., 2011).

The selectivity of the grid in relation to smaller length classes (~ < 20 cm) is less well understood. Catchpole et al. (2006) found that a gear fitted with a 35 mm Swedish grid caught more small haddock and cod than a standard gear. Hence to ensure that the capture of juvenile haddock, whiting and cod is minimised it will also be necessary to improve the size selection of the codend which could be achieved by increasing the mesh size of the square-mesh panel to at least 120 mm and positioning the panel at 3-6 m from the codline.

The potential impact on the introduction of a Swedish Style grid on catches is likely to be similar to those shown in the section relating to VIa *Nephrops* (see pages 11-12).

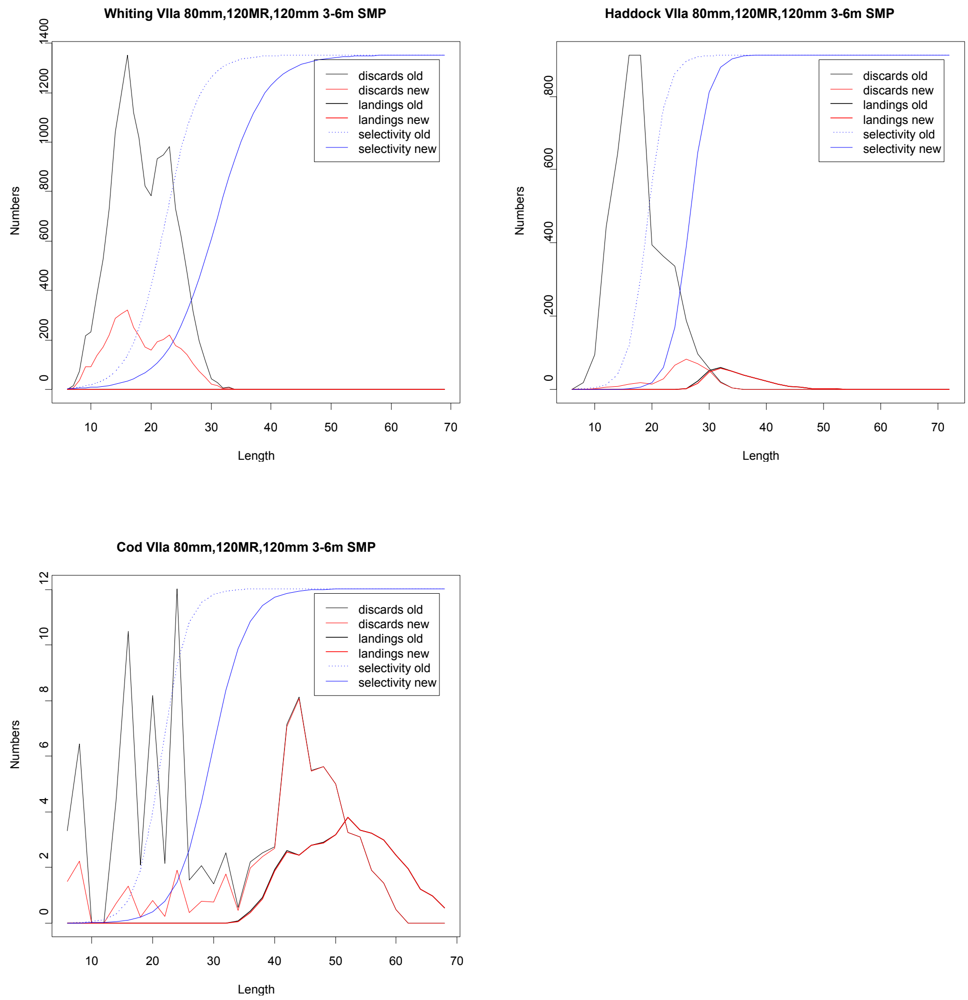


Figure 1.2.8 Simulated effect on haddock, whiting and cod catches (2010 population) of increasing the mesh size of the square-mesh panel to 120 mm (from 80 mm) and adjusting the position of the square-mesh panel from estimated 12-15 m to 3-6 m from the codline in the VIIa TR2 (Northern Irish) fleet.

	Haddock	Whiting	Cod
Reduction discards numbers	91%	74%	42%
Reduction landings numbers	5%	NA	1%
Reduction discards weight	78%	74%	7%
Reduction landings weight	3%	Na	0%

Table 1.2.3. Modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used in TR2/VIIa (i.e. a 120 mm square-mesh panel inserted 3-6 m from the codline in the Northern Irish TR2 VIIa fleet).

In summary, the current technical measures in force, the 80 mm square-mesh panel and codend configuration are inadequate to offer any meaningful protection to incoming recruitment, particularly 1 and 2gp fish, and offer very limited protection to the severely depleted cod stock in the area. To reduce the high levels of discards of haddock and whiting observed in the fishery and to maximise improvement in the spawning stock biomass of haddock, which has been declining in recent years and whiting, which is estimated to be at historically low levels, improvements in the size selectivity of the gears currently in use is urgently required. In the short term, such improvements would best be achieved through modifications to square-mesh panels by increasing mesh size to at least 120 mm, and citing the panels closer to the cod end i.e. 3-6 m and adjustment in codend construction i.e. increase in mesh size. There are also a number of other measures that have been shown to improve selectivity such as the square-mesh panels positioned at the fishing circle. Simulations have shown that large scale reductions in cod mortality are required for the potential rebuilding of this stock. Currently the only demonstrable method to achieve this is through the introduction of species selective gears i.e. Swedish Grids.

1.3 ICES Sub-Divisions VIIa and VIIfg – TR2 *Nephrops* (VIIa) and BT2 (VIIa/ VIIfg) - Plaice

ICES (2011) reports that, of the 1133 t of plaice caught in the VIIfg during 2010, 62% was discarded of which, 58% was attributed to the Beam trawl fishery, the remainder to the mixed demersal and *Nephrops* directed otter trawl fishery. In the Irish Sea, the fleet specific discard profile is somewhat different. ICES (2011) estimate a catch of 2892 t of which 2516 t was discarded (87%). Unlike the Celtic Sea, discards associated with the beam trawl fleet accounted for only 13% in the Irish Sea, the majority of discards are associated with the mixed demersal otter trawl fishery (90-99 mm) and the directed *Nephrops* fishery.

Given the fleet specific differences in discard profiles between the two areas, the technical means to reduce discards will be different. However, in both areas, in order to effect meaningful reductions in plaice discards, the mitigation methods are likely to result in significant alterations in the current catch (species and size) profiles for all the fleets concerned.

1.3.0.1 Current Technical Measures in force

The technical measures requirements for the TR2 fleet targeting Npehops is provided in the previous section. Given that there is no evidence to support that square-mesh panels have any impact on the selectivity of plaice, the small mesh size used to target *Nephrops* (70-89 mm) and other fisheries that target mixed demersal species, the current mesh size requirements offer little or no benefit for plaice and is the main contributing factor to the very high discard levels observed. To minimise the potential loss of target species (*Nephrops* and sole) there needs to be significant improvements in species selectivity in both the TR2 and BT2 fisheries.

1.3.0.2 ICES Sub-Division VIIa – TR2

ICES (2011) note that "in the eastern Irish Sea plaice are caught by the mixed demersal fishery, largely UK otter trawlers, and as a by-catch in targeted sole beam trawl fisheries, dominated by Belgian trawlers. Total effort (hours fished) in the UK fleets targeting plaice have declined to the lowest levels recorded.

Total effort by the Belgian beam trawl fleet has declined steadily from a peak in 2002. In the western Irish Sea, plaice are caught by the Irish and UK *Nephrops* fisheries: effort by these fisheries is greater than in the mixed demersal and beam fisheries combined".

Given that only 13% of plaice discards in the Irish Sea are attributed to the beam trawl fleet and that the targeted demersal finfish fishery is also in decline, the main source of discards are likely to be attributed to the TR2 fleet targeting *Nephrops*. Due to the lack of metier specific discard data, it is not possible to specifically attribute specific discard volumes between the various fleets.

However, given that effort of the TR2 *Nephrops* fleet is dominant, it is fair to assume that, at least in the Western Irish Sea, the introduction of measures to reduce discards in the *Nephrops* fishery will have a positive impact in reducing plaice discards. Given that any increase in mesh size that would result in meaningful reductions in plaice catches, e.g. increase in mesh size >100 mm would also result in significant reductions in the target species, the only realistic option is to introduce measures that improve the species selectivity of the current gear. As noted with the beam trawl, technical measures that reduce plaice discards are limited. Unfortunately there is no length selectivity data available that can be applied to the discards and landings length composition that allows for a detailed quantitative analysis as to the potential impact on plaice catches.

Drewery et al. (2010) tested a 35 mm Swedish grid in the Scottish *Nephrops* trawl fishery. The grid gear caught significantly fewer plaice than the control for lengths above 18 cm, with retention estimated to be 61% at 18 cm, decreasing to 3% at 35 cm. The *Nephrops* catch rate of the grid gear did not differ significantly from that of the control for carapace lengths ≤41 mm. Above 41 mm, the grid gear caught significantly fewer *Nephrops* than the control, with retention estimated to be between 75 and 90%.

Research conducted in the Celtic Sea (BIM, 2008) shows that the use of selection grids has the potential to reduce plaice discards in the *Nephrops* fishery by at least 60%. Figure 1.2.9 contrasts the catch weights from catch comparison trials where a 'standard' trawl was directly compared with a trawl fitted with a 35 mm grid.

Plaice selectivity data associated with a rigid sorting grid with a bar spacing of 35 mm tested in West of Scotland (Drewery et al., 2010) has been used to assess what the potential impact on plaice catches in the Irish Sea by applying the selection parameters to the landings and discards length composition of English catch data from the TR2 *Nephrops* fleet and Irish OTB fleet (Figure 1.2.10), the latter is this is not disaggregated to mesh size or target species.

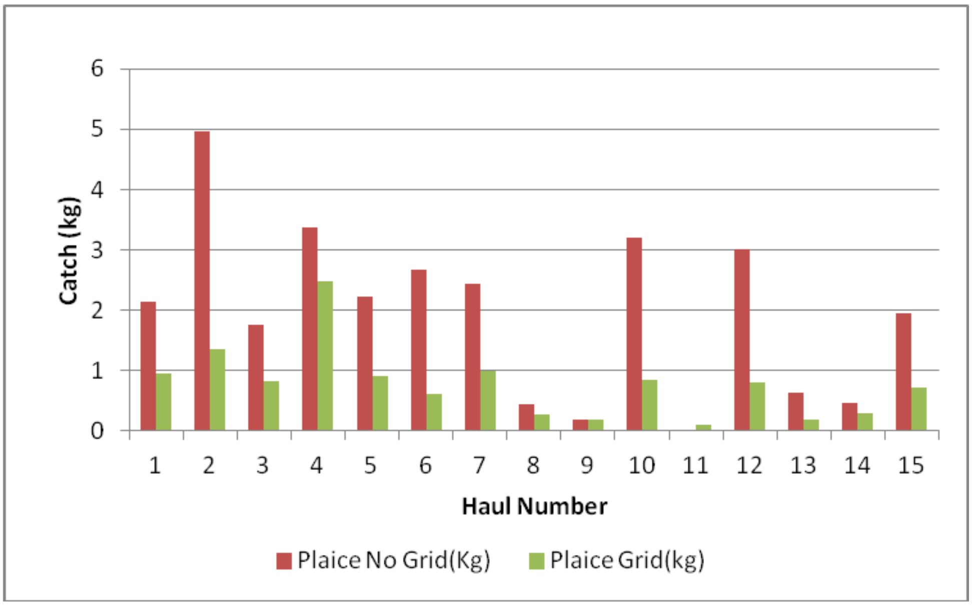


Figure 1.2.9. Comparison in plaice catches between a standard *Nephrops* trawl and one fitted with a 35 mm grid.

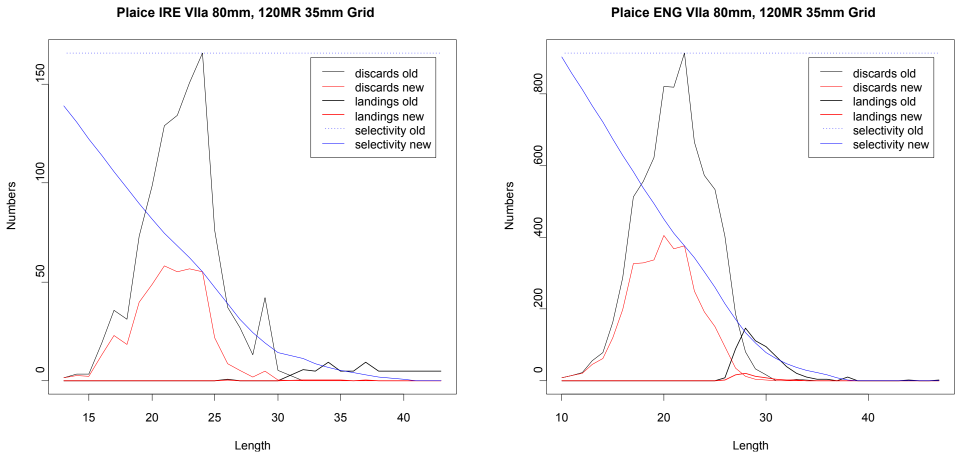


Figure 1.2.10. Simulated effect on plaice catches (2010 population) of introducing a 35 mm Swedish grid in the Irish and English TR2 fleets in VIIa.

	England	Ireland
Reduction discards numbers	55%	60%
Reduction landings numbers	89%	97%
Reduction discards weight	61%	65%
Reduction landings weight	90%	98%

Table 1.2.4. Modelled estimates of changes in discard rate and percentage change in plaice landings and discards (by weight and number) based on Irish and UK 2010 sampling data that would have occurred if the more selective gear had been used in TR2/VIIa (i.e. a 35 mm grid, with a standard 80 mm codend).

1.3.0.3 Potential technical modifications for the TR2 fleet operating in VIIa

The only demonstrable way to reduce plaice discards in the TR2 fleet (targeting *Nephrops*, is the introduction of a Swedish Grid or similar device. For TR2 fleets targeting mixed demersal finfish (90-99mm) the inclusion of a grid would result in losses of almost all target catch. Increasing the mesh size would help reduce catches of small plaice, but would also impact on some of the marketable catch.

1.3.0.4 ICES Sub-Divisions VIIa and VIIfg Plaice discards – BT2

There have been multiple studies conducted in the Beam Trawl fleet in relation to species selection however there is a general paucity of size selectivity data available for beam trawls. The minimum codend mesh size of 80 mm is adjusted to the minimum landing size (MLS) (i.e. 24 cm) for sole. This gear has a high selection factor on sole (SF=3.1–3.6, van Beek et al., 1981a,b; 1983) as compared to other flatfish (*P. platessa* L., SF = 2.17), and dab (*Limanda limanda* L., SF = 2.18). This implies that substantial by-catch of undersized plaice are being caught (van Beek, 1998).

Diamond meshes in the codend have a tendency to close when they are stretched during the fishing process or when catch accumulates in the codend. Due to the reduced mesh openings there is less chance for fish to escape from the codend. The T90 codend design turns the diamond mesh ninety degrees to make a square-mesh shape that has the capacity to remain open much more than a diamond mesh when under strain as the structure of the knot prevents the mesh from closing completely. This has the positive effect in improving the selectivity properties of the codend for roundfish. Depestele et al. (2008) show that the T90 codend increases the selectivity of Sole, Dab and Cod (the main target species), while allowing roundfish species, non-commercial fish and invertebrates to escape from the codend more easily than in a diamond mesh. In this way, total non-commercial catch weights could be reduced by a maximum of 50% in some trials, and even up to 58% when a T90 codend was used in combination with a benthic release panel.

As described earlier codend modifications have included square-mesh codends, which have been used in conjunction with square-mesh panels with favourable results (Revill et al*.,* 2007). Many of the gears described have being used alone or in combination with other gears, for example ILVO have carried comprehensive trials that combine the T90 codend and benthos release panel. From these trials they concluded that: the BRP consistently reduces the weight of discards and also when combined with the T90 codend with reductions of 21% and 18% respectively; commercial species were not lost during trials with the T90 codend and mean catches for sole and plaice actually increased, the BRP however demonstrated a small amount of sole loss but conversely showed an increase in the amount of plaice (+6.4%). Revill et al. (2007b) tested the combined effect of a benthos release panel in conjunction with a square-mesh codend. Even on its own, square-mesh codends were shown to improve size selectivity for roundfish compared to the traditional diamond shaped meshes (Robertson and Stewart, 1988; Sala et al., 2008; 2010; 2011). The combined effect of the square-mesh codend and benthic release panel is even more obvious, reducing overall discard rates in excess of 60%. However, Belgian experiments conducted in 1988 with square-mesh codends in the coastal beam trawl fishery showed no changes in the selective properties of the codend for sole (Fonteyne and M'Rabet, 1992). A Canadian study on American plaice and flounder showed that square-meshes were less selective than diamond meshes (Walsh et al., 1992).

Increasing mesh size from to 90 mm, 100 mm and 110 mm for the beam trawl fleet, is estimated to only result in significant impact on plaice catches if the mesh size is increased to at least 100 mm (Figure 1.2.11, Table 1.2.5), but is estimated to have a significant and negative impact on the landings of the primary target species, sole (Figure 1.2.12). Table 1.2.5 shows that in order to achieve even modest reductions in plaice discards e.g. 20% by weight by increasing the codend mesh size to 100 mm, will result in significant losses of marketable sole in the order of 28%. The potential impact on cod catches is also explored. Even increasing the mesh size to 110 mm, which is estimated to have resulted in a loss of 46%, would only achieve reductions in cod discards of 1.3% (Figure 1.2.13).

The potential impact on discarded sole estimated by the model is in line with the findings of Quirijns and Hintzen (2007). From comparative fishing experiments on commercial beam trawlers to appraise the effect of using 70, 80, or 90 mm mesh sizes on catch composition of sole and plaice in the beam trawl fishery in the southern North Sea and in each season. Their results show that increasing mesh sizes from 80 to 90 mm would lead to a direct loss of about 50% of undersized sole. However, they estimated that the losses of marketable sole would be much greater (32-47%) they also noted that there was no significant difference in the catches of plaice.

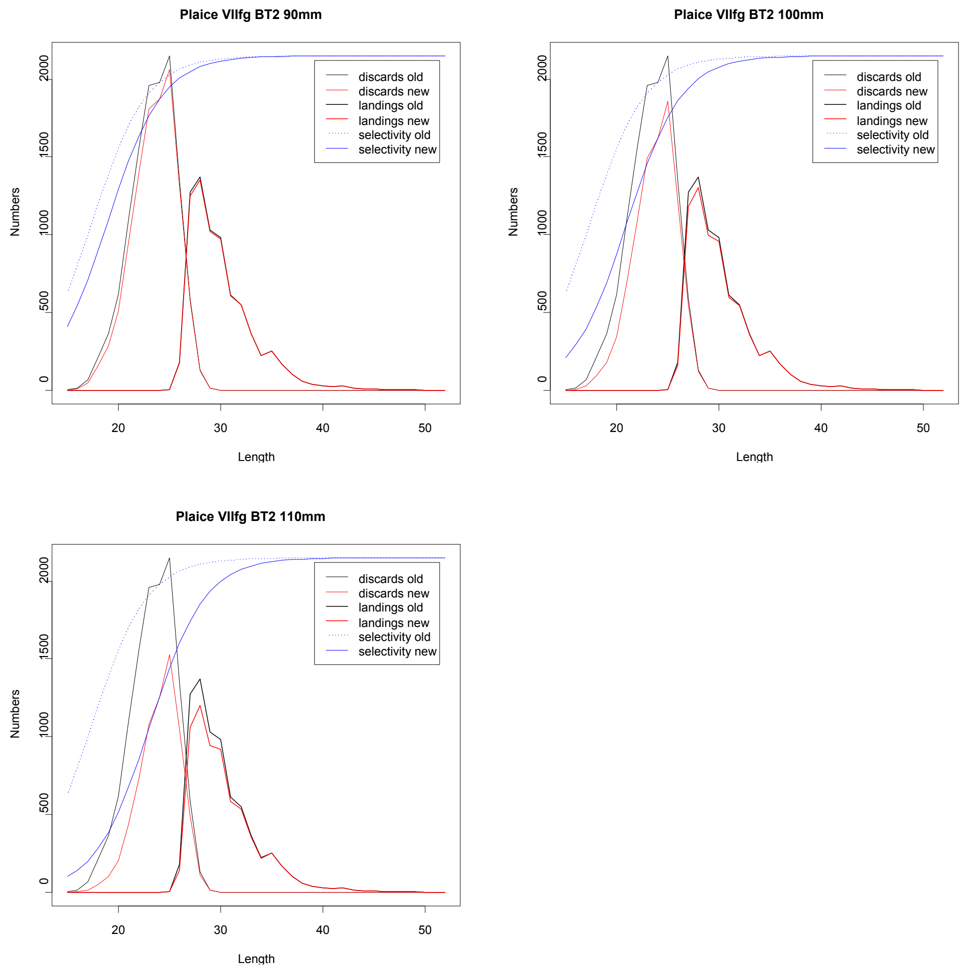


Figure 1.2.11 Simulated effect on plaice catches (2010 population) from the increase in codend mesh size from 80 mm to 90, 100 and 110 mm. Simulations based on Belgium catch numbers at length VIIa BT2 fleet.

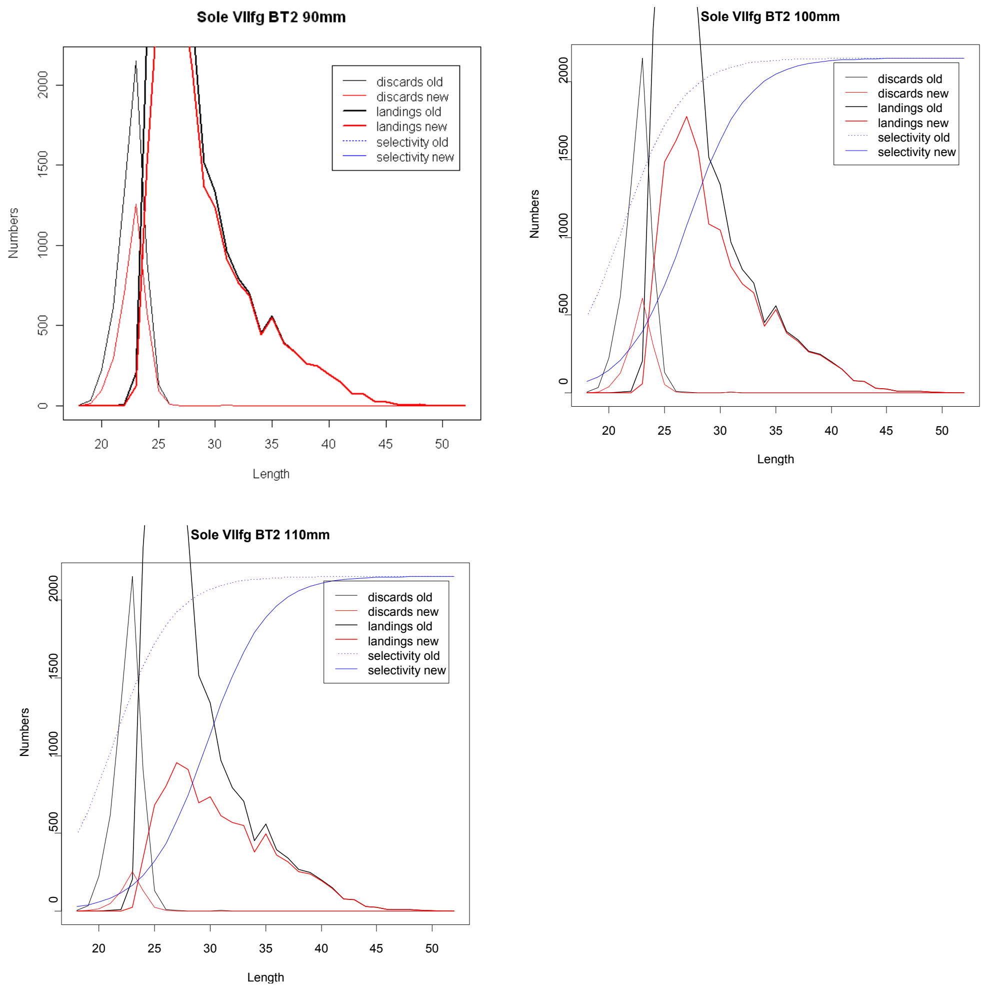


Figure 1.2.12 Simulated effect on sole catches (2010 population) from the increase in codend mesh size from 80 mm to 90, 100 and 110 mm. Simulations based on Belgium catch numbers at length VIIa BT2 fleet.

Species		Plaice			Sole	
Mesh Size	**90mm**	**100mm**	**110mm**	**90mm**	**100mm**	**110mm**
Reduction discards numbers	8%	23%	42%	44%	73%	89%
Reduction landings numbers	1%	4%	9%	17%	39%	59%
Reduction discards weight	7%	20%	37%	42%	72%	88%
Reduction landings weight	1%	3%	7%	12%	28%	46%

Table 1.2.5. Reduction in discards and landings by number and weight of plaice and sole associated with mesh size increase from 80 mm to 90 mm, 100 mm and 110 mm based on 2010 Belgium BT2 catch data from ICES Sub-Division VIIfg.

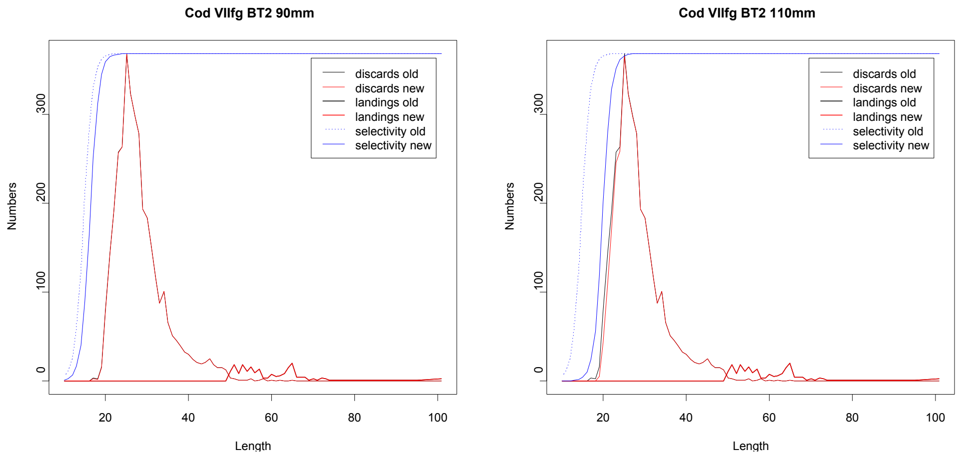


Figure 1.2.13. Simulated effect on cod catches (2010 population) from the increase in codend mesh size from 80 mm to 90 and 110 mm. Simulations based on Belgium catch numbers at length VIIa BT2 fleet.

1.3.1 Discard reduction of other species – BT2

Possible ways to diminish the adverse environmental impacts of beam trawling are technical gear modifications and the development of alternative fishing methods (Fonteyne and Polet, 2002; van Marlen et al., 2005). Several modifications have been investigated in two EU-funded research projects: SOBETRA (Optimization of a species selective beam trawl) (Fonteyne, 1997) and REDUCE (Reduction of the adverse environmental impact of demersal trawls) (Anon, 2002). The modifications tested in SOBETRA consisted of the use of large escape panels or escape openings in the top panel of the trawls to reduce the bycatch of roundfish species while minimising the effect on the flatfish catch rates. In REDUCE a benthos escape window in the belly of the trawl proved to be successful to reduce the benthos by-catch significantly while maintaining reasonable flatfish catch rates (Fonteyne and Polet, 2002). A consequent series of experiments dealt with improving these technical alterations, testing alternatives and demonstrating the new findings to the industry by trials aboard commercial vessels.

Several beam trawl adjustments investigating the effect of benthos escape modifications have been carried out. Fonteyne and Polet (2002) demonstrated that drops-out openings, an escape zone in the net without netting, large diamond- and square-mesh escape zones located after the ground rope of the gear were not effective in releasing the benthic by-catch and had the negative effect of decreasing the commercial catch to an unacceptable level. Square-mesh windows inserted in the belly of the net before the codend produced more favourable results with a reduction in benthic by-catch and a small, but acceptable, loss of commercial catch. Further investigations into square-mesh panels (Revill ant Jennings, 2005) trailed seven varying square-mesh panel designs all with mesh sizes between 140–160 mm basing this size on the results of Fonteyne and Polet (2002). These trials demonstrated invertebrate by-catches by 75 and 80% respectively. Large-meshed top panels have been utilized to release round fish from beam trawls. Trials using large-mesh top panels for the tickler chain type of beam trawls have been reposted by van Marlen (2003). These trials were conducted on two types of vessels specifically 300 and 1500-2000 horse powered vessels. The results from this study report that reduction of 30-40% of cod and whiting are possible without a significant loss of sole and plaice, the target species.

1.3.1.1 Potential technical modifications for the BT2 fleet operating in VIIa/VIIfg

While there are a number of potential options to reduce unwanted by-catch, including the reductions in cod by-catch, the modelled results and those from experimental research indicates little scope for reducing plaice discards to any meaningful level without significant impact on the catches of the primary target species, sole. This was also concluded by STECF (discard ref, 2008). Unless the mesh size and minimum landing size for sole is adjusted in tandem, the options to reduce plaice discards without impacting on the catches if marketable sole are severely limited.

2 ToR 2. Modification to catch composition regulations in ICES Division VIa

“STECF is asked to advise on the effect on discards and fishing mortality that would follow from a modification of the **catch composition rules for whitefish in VIa** (point 6 of Annex III to Regulation 43/2009) such that haddock would be removed from those rules; STECF is invited to advise on any other modification of those catch composition rules that are considered an appropriate reaction to the change of abundance of whitefish species in that area”

While the regulatory intention of catch composition regulations may be to limit the capture of specific species, in practice exceeding limits can be avoided by simply discarding any additional catches of a marketable fish (above minimum landing size) and are therefore unlikely to regulate fishing mortality. Additionally, there is no clear a priori relationship between the percentage of a given species in the catch and the associated fishing morality rate. This is because maintaining catches at a specified percentage of the overall retained catch may also be achieved by increasing the capture of other species (while keeping e.g. haddock catches at similar levels) as catch composition also depends on the abundance of other species in the mixed species assemblage.

Given that the ICES and STECF advice for VIa haddock predicts a significant increase in haddock catches in VIa, continued application of the catch composition regulation limiting the retention of haddock on board is likely to result in an considerable elevation of the capture and subsequent discarding of marketable (above minimum landing size) unless haddock is removed from the existing catch composition regulation. While it could be envisaged that such a removal could result in increased targeting of haddock in VIa, it is not possible to forecast how this will impact on fishing mortality, the removal of haddock from the composition regulation will alleviate the extent of regulatory induced discarding. STECF (11-09) notes that the provisions of Council Regulation (EC) 1288/2009 specifies that the percentage of cod, haddock and whiting that shall be retained on board by vessels operating in Division Via shall be no greater than 30% of the total catch on board.

If the by-catch restrictions remain in place in 2012, it is likely that fishing at F=0.3 in 2012 will give rise to increased discarding of haddock. In an attempt to prevent any increase in discarding of haddock, it would now seem appropriate to permit a directed fishery for haddock in Division VIa.

It should also be noted that a management plan is being developed for this stock and while this has not been evaluated by ICES, STECF notes that with reference to COM(2011) 298-final this stock is classified under category 2. The rules for category 2 prescribe that a TAC for 2012 of **10,200 t** for haddock in Division VIa should be proposed based on the ICES MSY-transition scheme. Applying the harvest rule in the proposed management plan for haddock in Division Via, would mean that a TAC for 2012 of **2,506 t** should be proposed. The current technical measures applied to the targeted gadoid fishery, if properly implemented, offer the highest selection profiles of any otter trawl fishery in the Europe. The primary issue for haddock in this area, at least during 2010, is the excessively high discard rates associated with the targeted *Nephrops* fishery, rather than any discard issue in the TR1, whitefish directed fishery. Given the catch forecast the continued inclusion of haddock in the catch composition regulations could result in discards associated with the TR1 fleet becoming a significant issue. It is considered that haddock should be removed from the (retained) catch composition associated with the TR1 fleet will help avoid unnecessary regulatory induced discards.

3 ToR 3. Technical Measures to Reduce Celtic Sea Cod Mortality

"*STECF is asked to advise on technical measures that could be introduced in order to reduce the age profile of catches and the fishing mortality concerning cod in the Celtic Sea, so that less young fish is caught which consequently could contribute to the reproduction of the stock and provide for higher weight per individual in the catches; STECF is kindly requested to identify the metier(s) for which the technical measures are being recommended*"

ICES does not provide data on the weight of landings and discards disaggregated by metier. However, WGCSE (2011) estimates that discard in 2010 are estimated to be greater than 500t and landings are broken down as follows: FR *Nephrops* fleet, 2%; FR gadoid directed, 52%; FR mixed benthic; 2%; UK beam trawl 9% and Irish otter trawl (all OTB metiers) 34%.

Given the high growth rate of Celtic Sea cod, the 2009 year class is now fully selected by the fishery and any adjustments in the selectivity characteristics of the gears in use is unlikely to yield any reduction in catches of the 2009 year class without impacting severely on the retention of other target species e.g. haddock and whiting. There is anecdotal evidence that the 2010 year class may also be relatively strong. Introduction of technical measures in the near future will offer some protection to this year class for a limited time (given the high growth rate). Given the large growth rate, Celtic Sea cod move through the selection window of the gear fairly rapidly, demonstrated by the mean length of 1 year old fish of ~38 cm increasing to ~60 cm by age 2. A summary of the length at age from the Irish sampling programme in provided in Figure 2.1.1. This demonstrates the rapid increase in mean length from age 1 to 2 and from 2 to 3 years old. Even at age 1, a reasonable majority of the year class with be beyond the selection span of even large improvements in selection, as they will be in excess of 40 cm, 2 year old fish (the 2009 year class in 2011) are well beyond only major changes in selectivity that could only be attained by very large changes in mesh selection.

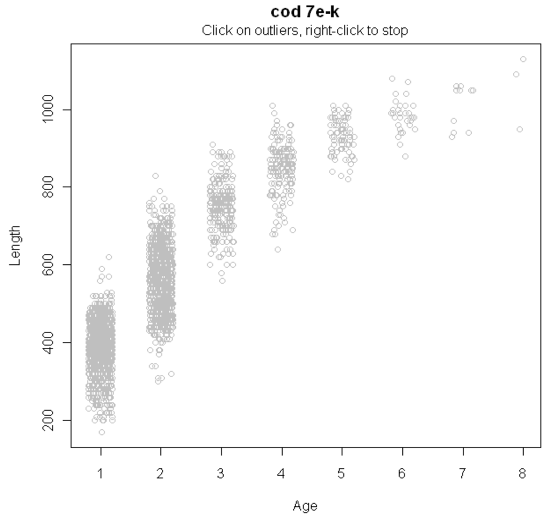


Figure 2.1.1. Length at age of Celtic Sea cod based on data from the Irish catch sampling programme.

Notwithstanding, adjustments to improve the selectivity characteristics may offer meaningful protection to any future cod recruitment. The impact that a more selective gear would have had on 2010 catches is provided as an indication of the potential benefits in reducing the retention of cod below minimum landing size. The simulation, based on Irish sampling data, assumes that the 'standard' codend configuration used conforms to the minimum gear regulations, 100 mm codend constructed with 4 mm double twine with a 100 mesh circumference.

Analysis based on the Irish otter trawl landings and discards at length indicate that if a 110 mm codend fitted with a 110 mm square-mesh panel inserted 9 to 12 m from the codline would have significantly reduced discarding of cod during 2010 (Figure 2.1.2). It is estimated that an increase in codend mesh size from 100 to 110 mm plus the inclusion of a 110 mm110mm square-mesh panel would have reduced cod discards by 70% and 65% by number and weight respectively while having minimal (3% reduction) in cod landings (Table 2.1.1). Similar reductions in discards of both haddock and whiting would also have been achieved, albeit with significant losses of marketable whiting.

As with all gears, there are a number of alternative options that could be considered. As an alternative to the 110 mm codend / 110 mm square-mesh panel, the introduction of a 120 mm square-mesh panel could be considered as an alternative or to bring the selectivity of the demersal gadoid fishery in line with the North Sea for example, the cod end mesh size could be increased to 120 mm.

It is noted that the North Western Waters RAC have proposed to their members a range of technical measures aimed at improving the size selectivity of Celtic Sea haddock and whiting (VIIfg). These measures include the voluntary introduction of square-mesh panels across the targeted whitefish fishery (>100 mm), the mixed demersal finfish fishery (90-99 mm) and the *Nephrops* fishery (70-89 mm). While the objective of these measures are primarily aimed at reducing haddock and whiting discards, here we provide an example of the potential impacts the propose measure in the whitefish fishery, introduction of a 100 mm square-mesh panel, inserted 9-12 m for the codline. Figure 2.2.3 shows the predicted impact such a measure would have had on the catches of cod, haddock and whiting if the panel had been used during 2010. While the impact is less than the scenario presented above (increase in mesh size to 110 mm with a 110 mm square-mesh panel), here is estimated that there would have been some benefit in terms of reducing cod discards (Table 2.2.2).

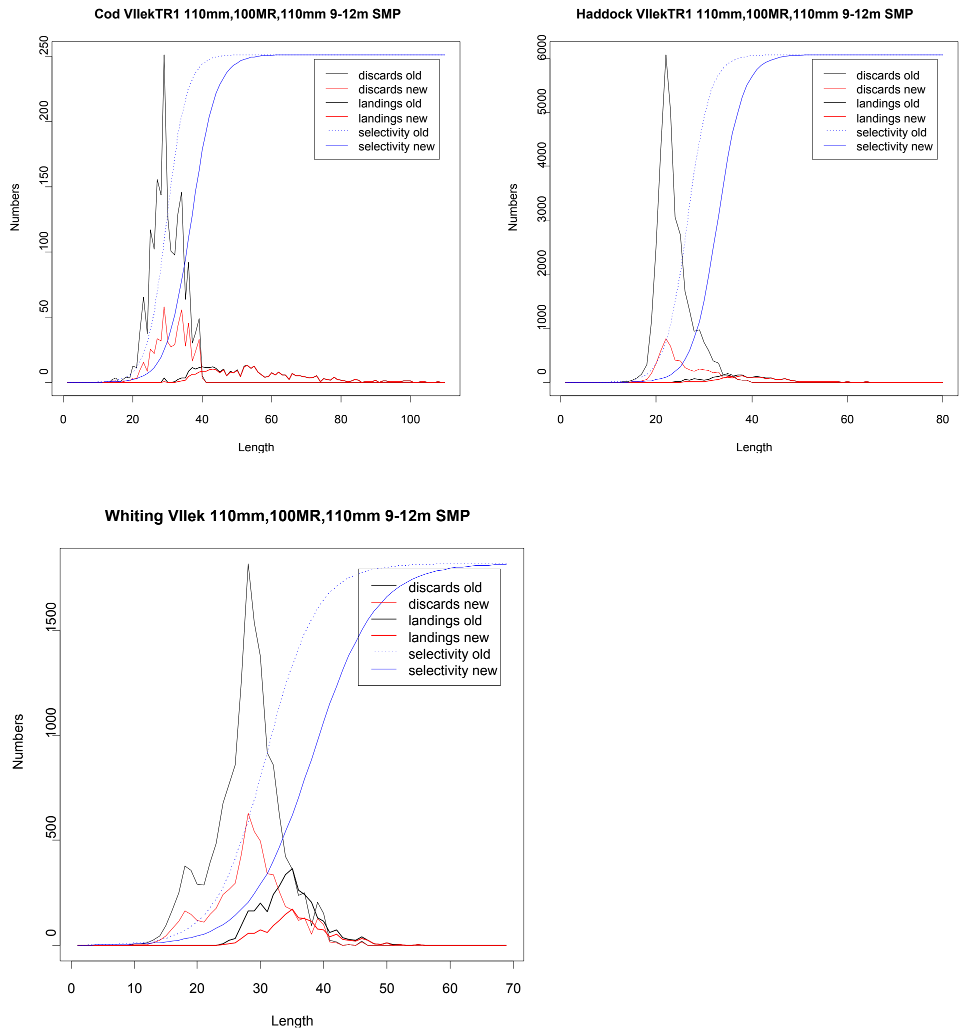


Figure 2.1.2. Predicted change in length composition for cod, haddock and whiting with the introduction of an increased in codendend mesh size to 110 mm and the inclusion of a 110 mm square-mesh panel inserted 9-12 m from the codline. Simulations based on length compositions from the Irish fleet OTB.

	Cod	Haddock	Whiting
Reduction discards numbers	70%	83%	61%
Reduction landings numbers	12%	25%	52%
Reduction discards weight	65%	78%	59%
Reduction landings weight	3%	13%	46%

Table 2.1.1. Modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective gear had been used in the Celtic Sea (i.e. 110/110 mm, 100 MR, 9-12 m SMP, and 4 mm double twine codend).

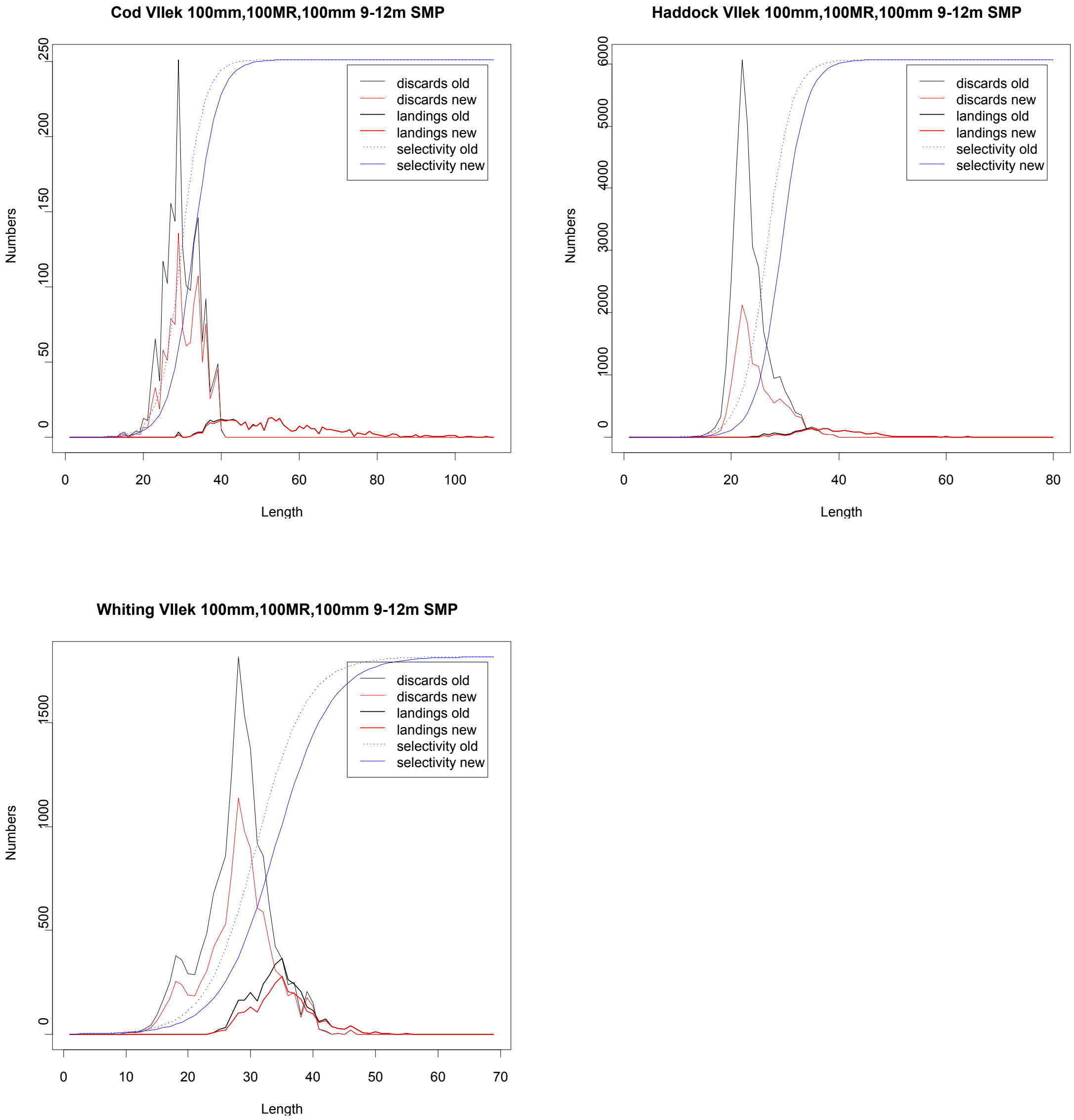


Figure 2.2.3 Impact of NWWRAC proposal for targeted gadoid fishery (>100 mm) in the Celtic Sea (ICES sub-divisions VIIek) (100 mm codend with 100 m SMP 9-12 m) on cod, haddock and whiting.

	Cod	Haddock	Whiting
Reduction discards numbers	39%	58%	34%
Reduction landings numbers	4%	9%	25%
Reduction discards weight	34%	51%	31%
Reduction landings weight	1%	4%	21%

Table 2.2.3. Modelled estimates of changes in discard rate and percentage change in landings and discards (by weight and number) that would have occurred if the more selective being proposed by the NWWRAC gear had been used in the Celtic Sea (i.e. 100/100 mm, 100 MR, 9-12 m SMP, and 4 mm double twine codend).

4 ToR 4. Fisheries Requiring Urgent Improvements in Selectivity

"*STECF should assess in which fisheries/stocks a rapid introduction of the technical measures is needed in order to avoid that abundant year classes cannot contribute to a replenishment of the spawning stock and to its potential for future reproduction."*

4.1 General Comments

It is not possible to predict the strength of incoming year classes beyond one year with any certainty and for Western Waters, the majority of IBTS surveys are conducted in quarters 3 and 4 so survey data that may provide better estimates of 2010 recruitment is currently not available, with the exception of VIa q1 2011 which estimates that the 2010 year class of haddock is of similar magnitude as the 2009 year class. Where available, the most recent ICES stock assessments indicate that for almost all species, with the exception of VIa haddock, whiting and VIIa plaice the 2010 year class is predominately weak. It should also be noted that while there is clearly a desire to maximise the potential of strong recruitment in any stock, for severely depleted stocks such as cod and whiting both in the Irish Sea and West of Scotland, it is also considered important to protect *any* recruitment even when that recruitment is estimated to be low. Measures that reduce *all* cod and whiting catches should be considered as a priority. To date, grids offer the best solution to reducing cod catches associated the TR2 *Nephrops* fleets. Similarly, while VIa whiting recruitment is estimated to be below the long term geometric mean, the 2010 years class is considered to be well above the recent (post 2005) average. Given the very low estimate of SSB, every effort should be made to offer protection to this year class as a matter of urgency.

For many of the stocks identified above, ICES and STECF consider that improvements in the selection pattern of the fleets exploiting them are required. The strong 2009 year classes of haddock (VIa, VIIbk) and cod (VIIbk) has have already been heavily discarded and by this stage, improving the *size* selective properties of *Nephrops* trawls (TR2 gears) without negatively impacting on catches of the target species, is unlikely to offer any major benefits for these as the majority of these fish are now beyond the maximum potential size selection options for the gear and measure to improve the selectivity of Celtic sea demersal whitefish fleets are likely to be limited. However, there is circumstantial evidence, from similar sources (e.g. recreational and commercial fisheries) that described the large 2009 cod year class, that ascertain that the 2010 year class is of similar magnitude. This will not be independently confirmed until the results of the 2011 Q4 IBTS surveys become available, but clearly is these observations are proved correct, then the high discard profiles observed in 2010 could again be repeated in 2011 and 2012. While improving the size selective properties of the whitefish targeted fleets will have limited benefit for the 2009 year class, the hind-cast analysis performed on the 2010 cod catch data shown in this report clearly shows that if the subsequent 2010 year class is strong then the immediate introduction of improvements in size selectivity into the whitefish fishery would be highly beneficial and any introduction of species selectivity into the *Nephrops* fishery e.g. through the introduction of grids, would allow the 2009 year class to further contribute to the SSB and limit the impact on the 2010 year class.

However, it would be seem prudent and precautionary to avoid any future repetition of the high discard levels seen in 2010 by introducing more selective gears into the fisheries *before* strong year classes enter the fishery. In general terms, urgent improvements are required in fisheries currently using mesh sizes less than 100 mm targeting flatfish (BT2) and *Nephrops* (TR2) and mixed demersal fisheries where mesh sizes less than 100 mm are permitted.

There are a wide range of technical measures available for all the fisheries described. These can be broadly split into measures that enhance the size selectivity e.g. increasing mesh size or those that adjust the species selectivity of the gears e.g. 'Swedish Grids'. While we have attempted to provide guidance on the type of adjustments that may be appropriate, many options are available.

In general, for *Nephrops* fisheries, there is a management choice to improve the size selectivity that will maintain the retention of fish by-catch in the fishery and/or to change the profile of these fisheries so that the fish by-catch is excluded, converting them to a single species fisheries. If it is the intention to exclude all large (~ < 40 cm) haddock, whiting and cod from catches then a trawl gear incorporating some type of Swedish grid should be considered. If it is acceptable to land certain amounts of these fish then square-mesh panels (of appropriate mesh size and appropriately positioned) should be considered and if it is the intention to protect the juvenile of these species then measures which modify the codend size selection such as mesh size increase and a reduction in the number of meshes in circumference should be considered. There are also other gear modifications such as cutaway, coverless and low headline trawls which could also be considered. The literature suggests that while these types of modifications may reduce catches of larger haddock and whiting they may not be very effective for cod or smaller haddock or whiting.

In mixed demersal fisheries where mesh sizes less than 100 mm are permitted, the mandatory introduction of square-mesh panels (120 mm) should be considered in conjunction with an increase in mesh size (100 mm) as this would help reduce discards of haddock and whiting considerably.

Beam trawl fisheries (BT2) continue to exhibit high levels of plaice discards. Reducing discard levels of this species it technically challenging without severely impacting on the retention of marketable sole. In order to achieve meaningful reductions in plaice discards, the mesh size would need to increase substantially i.e. 110 mm. The simulations presented here indicate that this would result in losses of sole in excess of 50%.

4.2 Area and Fishery Specific Recommendations

4.2.1 ICES Division VIa – TR2 (*Nephrops*)

The most appropriate method to protect the 2009 haddock year class, to maximise its contribution to SSB and to fully exclude it from the fishery would be to use a species selective device such as the Swedish grid.

To protect the juveniles of future year classes consideration should also be given to improving the size selection of the codend by increasing the mesh size to 95 mm, reducing the maximum number of meshes in circumference to 100 and moving the 120 mm square-mesh panel to 6 – 9 m from the codline.

4.2.2 ICES Division VIIa – TR2 (*Nephrops*)

The most appropriate method to exclude cod from catches in the TR2 fishery is to introduce a species selective device such as the Swedish grid.

The grid is also the only demonstrable method available to reduce the very high levels of plaice discards associated with this fishery.

Given the low biomass estimates of haddock and whiting and to protect future recruitment consideration should also be given to improving the size selection of the codend by increasing the mesh size to e.g. 95mm, increasing the SMP mesh size to 120 mm and repositioning the SMP at 3 – 6 m from the codline.

4.2.3 ICES Division VIIa – BT2

While the BT2 fleet operating in VIIa currently only contribute ~13% to the plaice catch, if fishing effort increases, for example if fishing opportunities for sole increase, the proportional contribution could increase. However, without increases in mesh size to at least 100 mm, the potential to reduce plaice discards are limited. Such increased in mesh size will be associated with significant losses of marketable sole unless the minimum landing size of sole is adjusted accordingly. Beam trawl fisheries are also associated with high by-catch of other fish species and benthos. There are a number of technical measures available to reduce such unwanted by-catch such as drop out panels and the use of very large mesh escape panels. Consideration should be given to the mandatory introduction of such measures.

4.2.4 ICES Division VIIfg –BT2

The same considerations identified above for the BT2 fleet operating in VIIa are applicable to the BT2 fleet operating in VIIfg.

4.2.5 ICES Divisions VIIfg –TR2 *Nephrops*

The proposals for VIa and VIIa *Nephrops* are also applicable for Celtic Sea *Nephrops* fisheries

4.2.6 ICES Divisons VIIfg – Fleets targeting cod

A number of options are available including an increase in mesh size to 120 mm which would bring the fishery into line with the North Sea demersal fishery. There are other options that would provide similar cod selectivity such as the introduction of a 120 mm square-mesh panel provided that the panel is positioned close to the codend e.g. 6-9 m.

5 Annex 1 - Model validation

We use the selectivity model of Madsen and Ferro in the EU Expert Meeting report of April/May 2003 to estimate the selectivity parameters for the different gears for haddock, whiting and cod.

This model uses data from 512 selectivity hauls on 8 commercial and 2 research vessel cruises using a broad range of gear designs. Fewer data were available for cod and whiting over more limited ranges of gear design so the authors used unweighted linear regressions to relate the haddock selectivity parameters to those of whiting and cod.

In general it is not possible to validate this model with experimental data from codends which meet the exact specifications set out in the legislation (e.g. EU legislation permits the use of lifting bags on 120 mm codends whereas most published data on this type of codend has taken place without a codend attached). It is, however, possible to compare model predictions with published experimental results over a range of parameter values which include those set out in the legislation. The three plots below demonstrate that the model captures very well the dependence of L50 on mesh size, number of meshes around and twine thickness.

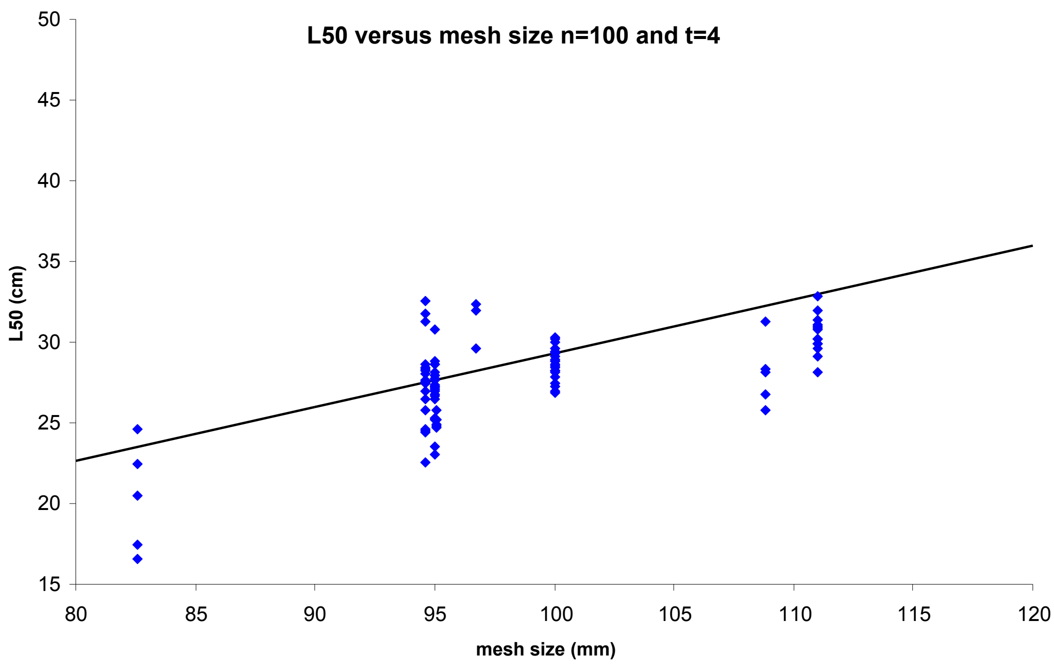


Figure 2.Modelled and observed relationship between L50 and mesh size

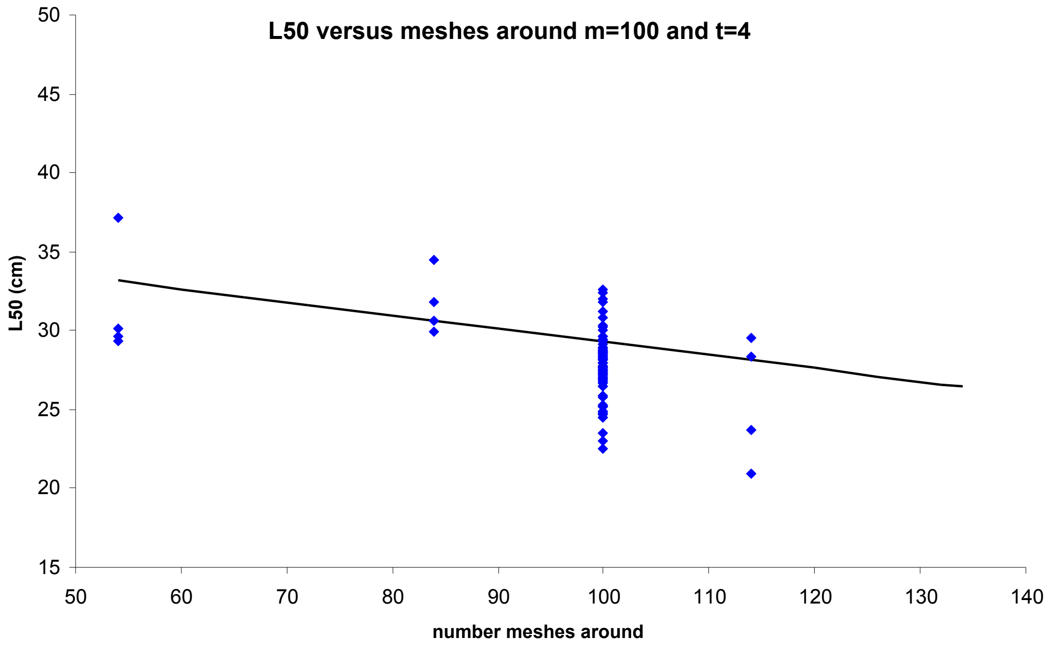


Figure 3. Modelled and observed relationship between L50 and number of meshes in codend circumference

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