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REDUCTION OF DICARDING PRACTICES (SGMOS-08-01)

SUBGROUP ON MANAGEMENT OF RESLOURCES (SGMOS), OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

STECF OPINION EXPRESSED DURING THE PLENARY MEETING

OF 7- 11 JULY IN HELSINKI

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1. BACKGROUND

In the follow up of the Commission "Communication on a policy to reduce unwanted by-catch and eliminate discards in European fisheries", the Commission will make concrete legislative proposals in 2008.

In this context the Commission has recently launched a consultation paper describing the approach to be used in the implementation of the communication. http://ec.europa.eu/fisheries/cfp/governance/consultations/consultation_250408_en.htm

This approach is based on a fishery by fishery basis, where in each fishery discard reduction targets are set within a fixed period of time. In order to prepare the Impact Assessment that will accompany the legislative proposal, the Commission is asking STECF to:

Terms of References of the working group have been:

Fisheries:

1) evaluate the general approach of the non-paper, ie. based on specific fisheries with annual "Maximum Allowable unwanted By-catch Limit" (MABL) during a fixed period of time: is the definition of the fishery broad or specific enough? Can a set period of time be fixed? Should gradual annual limits be set or should it be done in 2 stages, for example ?

2) assess the validity of the MABL for the beam trawls fishing in ICES area IV and VIId, and *Nephrops* trawlers fishing in area VII: is the initial discard percentage correct? Are the annual MABL percentage targets reachable? In which way (change of fishing grounds, closed areas/seasons, increase mesh size, etc) can the MABL best be reached ?

MABL for *Nephrops* fisheries in ICES area VII to be reached over 5 years

	Weight	numbers
Starting point	50%	60%
Year 1	25%	30%
Year 2	25%	30%
Year 3	20%	25%

Year 4	15%	20%
Year 5	10%	15%

MABL for beam trawlers in ICES area IV and sub-area VIId to reach over 6 years

	Weight	numbers
Starting point	70%	80%
Year 1	40%	50%
Year 2	40%	50%
Year 3	35%	40%
Year 4	25%	30%
Year 5	20%	25%
Year 6	15%	20%

Economics:

3) assess the economic impact of the progressive reduction of discards in the two fisheries considering the different MABL proposed and the possible scenarios identified in ToR 2) (change of fishing grounds, closed areas/seasons, increase mesh size, etc.).

4) assess the social impact of the progressive reduction of discards in the two fisheries considering the results of ToR 3).

2. STECF COMMENTS AND CONCLUSIONS

STECF observations

STECF reviewed the report of the SGMOS-08-01 Working Group on discards, noting that a considerable amount of information had been compiled in the short time available. STECF considers that SGMOS-08-01 adequately addressed most of the terms of reference. STECF notes however, that the sub-group did not explore fully all possible mechanisms to reduce discarding, in particular development of new markets for species or size classes currently discarded and adjustments to management systems to reduce discarding associated with legislative conflicts e.g. over quota discards or discarding fish below minimum landing size.

STECF notes that fishers discard part of their catch for a variety of reasons, either for market/economic considerations or to comply with regulations. Lack of marketing opportunities, limits on the capacity of vessels to retain fish onboard, quality considerations, or large price differentials between or within species (highgrading) all induce discarding. It is noted that the management framework can have a strong influence on discard rates. Fisheries that are managed extensively by output controls such as total allowable catch (TAC) and catch composition regulations are often characterized by high discard rates. For any given catch, fishermen will always have an incentive to discard any fish for which the economic costs of retaining, landing and selling the fish exceeds the expected market price. STECF notes that tackling the discard problem in a specific fishery therefore requires an understanding of the incentives to discard in that fishery.

STECF considers that in order to reduce discarding in European fisheries, a range of approaches may be needed depending on the cause of discarding and that this may require adaptation to existing management systems and development of market opportunities for species or size classes that are currently being discarded. STECF also recognises that discarding rates can be reduced through the adoption of more selective fishing techniques and support is available through the EFF. It may therefore be appropriate to create economic incentives for fishermen to change their fishing behaviour and/or to employ more selective gear in order to reduce discards. However, measures to reduce discards may result in reductions in landings and short term losses of revenues, and may act as a disincentive to adopt such measures.

STECF is broadly supportive of the overall approach suggested in the Commission consultation paper and notes that currently, costs and consequences associated with discarding are largely external to the business. Providing targets and associated periods for compliance internalizes these costs and provides incentives to reduce discards. However, successful outcomes are concurrent on a number of issues associated with policy implementation which are considered in detail in the report. STECF further notes that one consequence is that individual businesses or fleet segments could achieve a commercial advantage over others by failing to reduce their discards and mechanisms should therefore be introduced to minimise this.

STECF endorses the methodology used for the economic analysis of the beam trawl fisheries in IV and VIId and the Nephrops fisheries in area VII. However, due to absence of data disaggregated at the m□tier level and strong assumptions made (e.g. constant TAC uptake ratio for all species), the results can only be regarded as indicative. In an optional follow up WG such data should preferably be used and the assumptions should be reviewed. Notwithstanding, STECF notes that the Beam trawl fleets engaged in the area IV and VIId flatfish fisheries are currently unprofitable because of high fuel costs. While the situation is not as severe for Irish and UK fleets operating in area VII Nephrops fishery, many fleet segments are only marginally profitable. Further reductions in fishing opportunities that may be associated with the discard policy will worsen the economic situation.

STECF notes that individual metiers within the two general fisheries definitions are likely to have different economic situations and differing discard patterns although the aggregation of the available data precluded any metier-specific analysis. For the effective monitoring and remedial intervention and to assess the economic consequences, data monitoring should be done at a metier level.

STECF notes that the baseline measurements for both fleets are based on data collected under programmes that are not designed to provide precise data on discard rates across aggregated fisheries and typically only cover <1% of the total effort. Therefore these are likely to be imprecisely estimated and should be reviewed in light of new data becoming available. STECF considers that the first level of reductions (all species combined) identified in the consultation document is in principle achievable with existing technical methods. However, additional approaches are necessary in order to mitigate the negative economic consequences. STECF further notes that achieving the proposed reductions for individual indicator species (i.e. plaice and *Nephrops*) are likely to be more problematic and have a greater economic impact if they are to be achieved. STECF is not in a position, to determine with any degree of certainty, if the longer term targets (e.g. > 3 years) set out in the consultation paper are practically achievable or
economically viable.

STECF notes that the discarding of benthos has not been considered as a target in the subgroup report. STECF notes that the discarding of benthos may be considered a practice whose reduction may be desirable because of its ecosystem effects and other adverse effects and should therefore be included as a measurable element of discard reduction targets. STECF notes that methodologies for reducing discards will take time to develop and test. The development and implementation phase should allow sufficient time for various methods of reducing discards to be investigated and a subsequent period allowed for assessing the

reduction in discard levels realised. For the fisheries studied by the Working Group, the development and implementation phase is likely to take of the order of two years. Once effective approaches have been developed and implemented, a monitoring phase should follow, during which the achievable discard reduction would be measured. STECF notes that it is important that the monitoring phase is sufficiently long to allow for seasonal fluctuations and considers that one year is the minimum period necessary to quantify target reduction levels. This same reference period should be used subsequently in the measurement of discard rates in the fishery for the purposes of monitoring the achievement of agreed target levels.
The sub-group recommends that a standardized sampling strategy and raising procedures be adopted across all member states engaged in the same fisheries to ensure data compatibility. However, STECF considers that member states should be able to propose individual sampling strategies tailored to their individual needs and these should be agreed and coordinated on a regional level by appropriate authorities. STECF recognizes the need to ensure that discard policy monitoring programmes do not adversely impact on current sampling programmes conducted under the auspices of the Data Collection Regulation.
STECF concludes that rather than using discard rates as a metric to determine whether policy targets have been achieved, reductions in absolute levels at a metier level should be used, as rates can obscure and underestimate significant reductions in discard levels and do not offer indications of the impact on non-commercial species. STECF comments that in the case of individual species for which analytical stock assessments exist, a metric that is relative to abundance (at age) can be used, i.e. the annual estimates of discard-F. For example, in the case of North Sea plaice, discard-F-at age is estimated annually in the stock assessment.
STECF considers that target levels should be based on numbers rather than weights discarded, as this will provide the best measure of overall conservation benefits and avoid potential conflict between the two metrics.
STECF considers that the policy objectives would be most effectively served and measured by the adoption of a monitoring programme that monitors the discard levels aggregated across agreed species. STECF considers that for some species such as those subject to recovery plans species-specific target reductions should be agreed and implemented.
STECF notes that, from an economic standpoint, the costs attributable to by-catch and discarding are currently external to the fishing business, representing costs to society (lower long-term gains, unwanted by-catch of species valuable to people, willingness to pay for protection, etc.). Setting targets to reduce discards as proposed in the consultation paper, results in an attempt to internalise these costs to fishing businesses. Internalising external costs will lead to an increase in the operational costs of the fishing business that are not easy

to compensate in the short term, due to fishers\u2019 status as \u201cprice takers\u201d (i.e. they can notdirectly influence fish prices).

STECF suggests that introduction of a variety of incentives to reduce discards should be considered. Reduction of internal costs by rewarding fishermen for ecological services by avoiding by-catch may be a good instrument to compensate for any additional costs, at least for a transitional period. In the long run, fishermen should be able to compensate for such costs if they benefit from higher profitability owing to the recovery of stocks. If external effects are relatively small, they may be able to adjust their cost and earnings structure to stay profitable through the use new technical measures or marketing instruments (special products, eco-labelling etc.).

STECF suggests using the instruments of Axis III of the European Fisheries Fund to develop pilot projects or new management tools to reward fishermen for a transitional period. STECF notes that this is systematically not a subsidy but a reward for a service to society which should also only cover costs for a specified period. In the Nephrops fishery in VII avoiding bycatch and discarding of small hake may increase catch

possibilities in the gill net fishery for hake. If such obvious links exists between reducing external costs in one fleet segment which result in an increase in revenues in another segment a partial cost recovery for governments may be possible.

STECF Conclusions and Recommendations

STECF concludes that to assess the impact of the policy it is necessary that discard data be collected at a metier level and with appropriate data for raising metrics to determine the absolute changes in discard levels. Also economic data should be collected on a metier level.

STECF concludes that a group should be set up to evaluate member states\u2019 proposals for monitoring and data raising methodologies at appropriate metier levels.

STECF concludes that a mid-term review should be conducted to assess the initial success of the policy and propose changes to targets in light of new information if necessary.

STECF concludes that the industry needs to be provided with timely, periodic data from monitoring programmes to determine how effective their measures are in achieving the goals so that they have sufficient temporal scope to adapt if further adjustments are required.

STECF suggests that a system of a variety of incentives to reduce discarding be introduced. In the consultation paper sanctions for non-compliance with the overall targets are already discussed. Additional programs to support fishermen during the transition period to practices with lower external costs may substantially increase the probability of success.

STECF further concludes that there is very limited knowledge on the specific costs of discard reduction measures. STECF suggests that MS should collect data on these costs in the ongoing pilot studies. Such costs include inter alia, costs for storage requirements for bycatch not currently landed, costs in time associated with sorting the catch, any compulsory or voluntary technical changes and associated costs, costs of steaming time to fishing grounds etc. With these additional data, it may be possible to calculate any changes in cost structure by adopting particular discard reduction measures and offering appropriate rewards for ecological services through pilot programmes conducted under the EFF.

ANNEX

STECF/SGMOS-08-01 WORKING GROUP REPORT ON

REDUCTION OF DISCARDING PRACTICES

Ispra, 16 -20 June 2008

This report is the opinion of the expert working group on Discards (STECF/SGMOS-08-01) and not of the Scientific, Technical and Economic Committee for Fisheries (STECF)

This report does not necessarily reflect the view of the European Commission and in no way anticipates the Commission's future policy in this area

3. INTRODUCTION

Despite the availability of numerous technical measures to reduce unwanted catch, many European fisheries suffer from unacceptably high levels of discards. Central to this problem has been a lack of cost associated with discarding at a business (vessel) level and a regulatory framework that has focussed on regulating landings rather than catch. In many instances, fishermen are compelled to discard in order to comply with regulations or because of a lack of marketing opportunities. This problem is generally exacerbated in multi-species fisheries where individual quota allocations and catch (landing) composition regulations are mismatched between fishing opportunities and availability. In addition, many fisheries suffer from over reliance on incoming recruitment and targeting fish at or above minimum legal size and as the selectivity of fishing gear is not 'knife edged' retention of fish below minimum size can be significant. Clearly, there is a need to rectify this problem to minimise waste, increase yield from the fishery and to comply with the general ethos of the ecosystem approach to fisheries management.

3.1. A prescriptive to a target based approach

In the Commission consultation paper, it is proposed to adopt a policy that focuses on achieving specific reductions in the discarding of unwanted by-catch. This approach differs significantly from previous methods that focussed on defining the mechanics (mesh size, closed areas etc) on how to reduce discards to a non-defined level rather than what the minimum levels should actually be. An analogy can be taken from general environmental legislation, which defines the maximum acceptable levels of pollution rather than on the specific technologies a polluter has to adopt. The Commission consultation document states "*management measures at Community level should focus on establishing what outcomes should be achieved rather than the means to achieve them*" This results in an approach to reduce discarding that places the onus at a member state and individual business (vessel) level on how to achieve these targets in practice. This requires a less prescriptive approach and can potentially allow more flexibility to develop methodologies that are more suited to individual circumstances.

3.2. Terms of Reference (ToR)

1) Evaluate the general approach of the non-paper, i.e. based on specific fisheries with annual "Maximum Allowable unwanted By-catch Limit" (MABL) during a fixed period of time: is the definition of the fishery broad or specific enough? Can a set period of time be fixed? Should gradual annual limits be set or should it be in 2 stages, for example?

2) Assess the validity of the MABL for the beam trawls fishing in ICES area IV and VIId, and *Nephrops* trawlers fishing in area VII: is the initial discard percentage correct? Are the annual MABL percentages targets reachable? In which way

(change of fishing grounds, closed areas/seasons, increase mesh size, etc) can the MABL be reached?

3) Assess the economic impact of the progressive reduction of discards in the two fisheries considering the different MABL proposed and the possible scenarios identified in ToR 2) (change of fishing grounds, closed areas/seasons, increase mesh size, etc.)

4) Assess the social impact of the progressive reduction of discards in the two fisheries considering the results of ToR 3)

Participant List

SCIENTIFIC EXPERTS:				
a) STECF Members				
Norma n	Graham	Marine Institute,Rinville Co Galway, Ireland	+353 (0)91 387307	norman.graham@marine.ie
Ralf	Döring	University of Greifswald Markt 25,Greifswald, Germany	0049 3834 864127	doering@uni-greifswald.de
Hazel	Curtis	Sea Fish Industry Authority, Edinburgh, UK.	0044 131 524 8664	h_curtis@seafish.co.uk
b) Invited experts				
Kelle	Moreau	Institute for Agricultural and Fisheries Research, Ankerstraat 1, Oostende, Belgium	0032 486 12 58 77	kelle.moreau@ilvo.vlaanderen.b e
Edwin	van Helmond	IMARES Haringkade 1 Ijmuiden, Netherlands	316212812 58	edwin.vanhelmond@wur.nl
Pieter-Jan	Schon	Agri-Food & Biosciences Institute, Newforge Lane, Belfast, UK.	+44 28 90255015	pieter-jan.schon@afbini.gov.uk
Jens	Ulleweit	Federal Reseach Centre for Fisheries Palmaille 9 Hamburg, Germany,	0049 40 38905217	jens.ulleweit@ish.bfa-fisch.de
Thomas	Catchpole	Cefas Pakefield Road Lowestoft,UK.	447810086 958	thomas.catchpole@cefas.co.uk
Alain	TETARD	IFREMER Avenue du Général de Gaulle BP32 Port-en-Bessin, France	33 2 31 51 56 00	Alain.Tetard@ifremer.fr
Philip	MacMullen	Seafish, St Andrews Dock, Hull, UK.	+44 1482 327837	p_macmullen@seafish.co.uk
Emmet	Jackson	Bord Iascaigh Mhara, Crofton Road, Dublin	353872432 664	jackson@bim.ie
Daniel	McDonald	Bord Iascaigh Mhara,National Fisheries College, Greencastle, Ireland.	353872585 517	mcdonald@bim.ie
Ross	Fitzgerald	Marine Institute Rinville Galway, Ireland	353917002 00	ross.fitzgerald@marine.ie
Grant	Course	CEFAS, West Strand, Whitehaven, Cumbria.	+44 1946 692654	grant.course@cefas.co.uk

C) JRC				
Doug	Beare	Maritime Affairs, Joint Research Centre, Italy.	+39 0332890302	Doug.beare@jrc.it
Paul	Hussein	Maritime Affairs, Joint Research Centre, Italy.		Paul.hussein@jrc.it
OBSERVERS				
Mike	Park	SWFPA, North Lodge, Stonehaven, Scotland, UK.	7710504773	m.park@btconnect.com
Geert	Meun	Dutch Fish Product Board, PO Box 72, RISWK, Netherlands	31703369629	sbeekman@pvis.nl
EUROPEAN COMMISSION				
Lisa	Borges	DG Mare, Rue Joseph 11 79, Brussels.		Lisa.borges@ec.europa.eu
Doug	Beare	STECF secretary, JRC, Ispra, Italy.	+39 0332890302	Stecf-secretariat@jrc.it

4. EVALUATION OF THE GENERAL APPROCH (TOR 1)

Evaluate the general approach of the non-paper, i.e. based on specific fisheries with annual "Maximum Allowable unwanted By-catch Limit" (MABL) during a fixed period of time: is the definition of the fishery broad or specific enough? Can a set period of time be fixed? Should gradual annual limits be set of should it be in 2 stages, for example?

4.1. General Comments

SGMOS 08-01 considers that the general approach as defined in the consultation paper is a significant and generally positive departure from previous prescriptive methods to reduce discards. Under the current regime, the costs associated with discarding are largely external to the individual operator and therefore present no real incentive to reduce discarding. The target-based approach internalises the costs associated with discarding, at least at a fishery level. It therefore provides a stronger incentive to reduce discards because failure to do so results in a reduction in fishing opportunities. Setting pre-defined targets introduces a greater level of flexibility at a vessel level as to how the targets are actually achieved, rather than prescribing the means by which they must be achieved. This places the onus on the industry to identify and test the most appropriate mitigation tools tailored to their specific circumstances – which it is often better placed to do. The sub-group note however that in order to maximise the potential of the plan the motivation for change must be firmly lodged at the level of individual vessel operators.

The sub-group also considered several issues that the consultation paper does not raise but that are significant in terms of enabling its objectives to be delivered.

- The evidence – or data – upon which the sub-group's judgements are based, is generally not precise and in order to be representative, discard rates must be benchmarked at the level of individual métiers because of the range of variation between those métiers. Benchmarking discard rates at the operational level of métiers is not possible to the degree of precision required.

- Predicting the feasibility of targets based five years ahead also requires medium term forecasting that is not supported by evidence and therefore the sub-group views are largely subjective. To this extent, the expectations of the logical development of target-based policy must be viewed as largely aspirational. This concern is expressed in a number of caveats in the following sections of this report

- There is a growing body of evidence that describes how many of the devices that are now available to reduce discards may result in traumas that will cause mortality of fish in ways that cannot easily be quantified. Similarly, fishers may respond to a discards reduction policy by landing fish that they are legally entitled to do in order to reduce discard levels (e.g. where TAC uptake is low due to market driven factors). Therefore, reducing discard rates may, in part, only move fishing mortality elsewhere and not fully deliver the expected conservation benefits.

- Energy-intensive fishing methods – particularly methods like beam trawling – are becoming increasingly financially unsustainable, and the financial outcomes are now very different compared to the time when the non-paper was drafted. The sub-group has a very real expectation that the beam trawling sector may well cease, or reduce to a small proportion of its current size, within a period of a year or two resulting in reduced overall levels of discarding.

- Achieving the levels of discard reduction mooted in the non-paper is challenging and would not be possible unless fishermen were able to adapt existing, generic selectivity devices to their own needs. The legality – or exact specification – of many of these devices is not established and attention will need to be given to the means by which fishermen's ingenuity can be engaged to this end.

4.2. Fishery definitions

The sub-group note that the two fisheries identified, ICES IV and VIId beam trawls and Area VII *Nephrops* trawls are broad definitions. It is important to note that each contains several discrete métiers that are known to exhibit significantly different discard rates and make very different contributions to the overall level of discards. Member states wishing to avoid the risk of punitive sanctions will clearly want to introduce measures that provide the greatest reductions in discarding. It will therefore be in their best interests and that of the discard reduction policy to allocate mitigation resources to those métiers making the largest contribution to discards and to monitor targets at a métier level. It should be noted however that for many Member States this degree of discard data resolution is not yet available.

Failure to implement and monitor the plan at a sufficient resolution, for example at a business (vessel) level, could result in relatively slower progress in achieving targets. Inaction by some operators within a fleet could result in the dilution of actions taken by others, although such intransigence could then result in peer pressure being applied to non-compliant vessels. *The sub-group conclude that it is important to find mechanisms that ensue that some vessels do not obtain a commercial advantage over others by failing to limit their own discards.*

4.3. Data needs

Current levels of discard sampling are low, typically less than 1% of the total effort in any given fishery. This means that baseline estimates may be imprecise and are likely to change with the addition of further data. Coupled to this, discard rates are highly variable within and between years and increases in sampling levels are required in parallel with the discard reduction plans. Such increases are essential in order to effectively evaluate the plan following its introduction. It is necessary that sampling protocols and discard rate calculation are standardised across member states in order to ensure comparability, particularly where several member states are engaged in the same fishery.

The sub-group note that discard data currently collected under the Data Collection Regulation (DCR) are used primarily for assessment purposes and thus far have no utility for control and enforcement purposes. It is recommended that the data collection programmes for scientific purposes and for monitoring the implementation of the discard policy are kept separate and fully independent. Monitoring data could be cross-checked against DCR estimates for validation purposes, but the sub-group had a general concern that combining the two programmes could potentially bias data through misreporting or biased sampling.

4.4. Policy objectives, Target Setting and Definitions

The choice of targets needs to be based on the particular objectives of the policy. This may be interpreted as reducing the discard rates of all or a select number of species; minimising waste to meet societal goals; or improving exploitation in a single species context, or at a wider ecosystem level. The consultation paper suggests that all of these goals are important. It is therefore necessary to select appropriate measures and targets that encompass these objectives. In some cases, meeting all objectives would be difficult or impossible to achieve at fishery level, especially if the fishery spans across management areas. Setting clear objectives are imperative in establishing measurable success criteria for the policy. Having too broad objectives could potentially complicate any regulation associated with the policy and will negate the attempt to simplify the associated technical regulations. It is also necessary that, concurrent with the implementation of the plan, are the data collection tools necessary to determine whether the targets are reached and what the overall benefit of the policy has been. The policy proposed is radically different from the *status quo* and the degree of success it achieves must be clearly established.

The non-paper defines targets based on a percentage baseline and subsequent percentage reductions in weights and numbers of discards. The sub-group also discussed other possible metrics such as using estimates of fishing mortality (F) by age as an alternative approach. This could offer some significant advantages particularly in dealing with 'spikes' in recruitment which could cause problems in achieving reductions based on percentages. Against this, the sub-group recognised that reductions based on F were reliant on comprehensive analytical assessments being available. This is not the case for all species. The sub-group concluded that the use of F by age as a target would be more complex to monitor and to disseminate to stakeholders.

The sub-group identified four potential approaches for defining targets and the advantages and disadvantages of each were evaluated. The range of arguments for and against each of these options is tabulated in table 1. The general suitability of each was also assessed against the broad policy objectives of the proposal. The choice of target criteria will influence the particular business solution adopted by individual vessels to achieve their targets, provided that the proposed sanctions can incentivise change in practice. The four approaches for estimating progress towards discard targets were:

i. aggregated data sampled from all fish and shellfish species (as currently used in the non-paper),
ii. using a range of fishery-specific indicator species based on expert judgement,
iii. using only commercial species, and
iv. combining aggregated species but also defining fishery-specific indicator species.

The major disadvantage of using criteria based on an aggregation across all species is that any reduction may not necessarily achieve benefits to stocks of particular concern. This would be possible if discard targets were achieved by reducing the discards of other species. However, there are several advantages from a practical and economic perspective in that the choice of species to focus on is left to the operator. This could result in achieving the target more quickly as attention is likely to focus on the particular species that are more readily avoided through spatial adaptations or excluded from a particular gear whilst minimising the impact on the target species.

The sub-group concluded that conservation interests would be most effectively served by the adoption of option iv: the combination of aggregated species data with fishery-specific indicator species which should also include species subject to recovery plans.

The inclusion of specific indicator species allows for the selection of species that are of particular concern, for example recovery stocks, and the mitigation tools can then be tailored specifically to those species. The corollary to this is that reductions in other species may not be realised and these continue to be discarded at current levels. From a control perspective, this approach could be more open to misreporting, particularly if self-sampling programmes are required to meet coverage levels. It is also important to select species that are representative of the entire fishery. This is likely to be a subjective judgement and potentially difficult where a number of métiers exist in the fishery. The sub-group also note that where a species that is subject to a recovery plan and is caught within the defined fishery, then these should also be included as an indicator species.

Anon (2007) noted that there are two possible methods available to derive discard rates: a mean of the discard rates across trips and aggregating catches across all trips and providing a single point estimate from the total landings and discards. The first option gives the opportunity to also provide an estimate of variability, but the mean rate can be skewed by the inclusion of values that are derived from low catches that may be atypical of the underlying trend. In addition, discard rates derived from shorter, more frequent trips will have a greater influence than rates obtained from longer, less frequent trips. However, this can be minimised if sampling programmes are weighted based on spatial and temporal métier activity. As a result of these *potential* biases, *the sub-group concludes that it is better to present single estimates based on catches aggregated across trips rather than the mean trip estimate*.

Basing the measure of reducing discard on *rates* of both commercial and non-commercial species discarded will obscures the effect at a species level. There are a number of scenarios where using rates alone will not provide a true measure of success in reducing the absolute levels of discards. Non-commercial species will continue to be discarded at a rate of 100% due to the absence of a marketable component, yet the relative reductions are the most important from an ecological perspective. Similarly, if a particular mitigation method also results in significant losses of marketable fish, the perceived benefits will be lower if using discard rates as the only measure. While gear modifications can result in significant discard reductions relative to 'old' and 'new' gears, if the population on which they are fished contains a high proportion of small fish, the discard rates will still continue to be high despite significant improvements in selectivity (see section 9.3.1 for further information). Finally, using only discard rates when a particular fishery such as the beam trawl, lacks the possibility of technical measures to reduce indicator species (e.g. plaice), reductions have to be established by reducing fishing effort or the use of protected areas. The effect of these measurements will not be obvious if expressed as reductions in discard rates although reductions in absolute discards will be significant. Therefore, these impacts can only be evaluated by quantifying the absolute reductions. The sub-group therefore conclude that *the overall effectiveness of the policy should be measured by the reduction of discard in **absolute** terms rather than **rates***. *Catch (landings + discards) data by weight and numbers at a métier level plus an* *appropriate raising metric (total effort and/or landings by métier) must therefore be collected in parallel.*

When using discard rates as a metric, for individual species for which their discard levels may change without affecting their discard rates e.g. those with no market value (100% discard rate), it is necessary to quantify their relative contribution to the overall discard rate (all species combined) to determine whether there is an actual impact on the level of discards.

Two targets are defined in the consultation paper, based on discard rates by number or by weight. *The sub-group concludes that it would be advisable to select only one as situations could arise where one target is met and the other is not. Selecting one avoids this problem and to provide reductions that achieve the highest conservation benefit in terms of protecting juveniles, it is proposed that discard rates based on numbers rather than weights be used.*

4.5. Target setting and appropriate periods

The issue of the 'accounting period' is potentially very problematic, 'snapshots' of discarding mean very little; and discard data are of limited utility given the high level of variability; yet the reduction in discarding is expected to be demonstrated adequately. These elements are extremely difficult to reconcile. It wouldn't be equitable to assess the first period of involvement in this strategy by including data from the very beginning of the period when no change had taken place. But neither would it be possible to make a sensible assessment of the situation at the very end of the first period The proposed targets do acknowledge this reality by combining years one and two but the same issues remain in subsequent years. Considering seasonal changes in discard patterns in most fisheries, either relating to local fishing grounds or biological population structures, changes in discard rates needs to be calculated over a year at a minimum. It should be noted that achieving targets in years of strong recruitment will be difficult, particularly for individual indicator species. This implies that the annual baseline rate is reasonably accurately established and the initial accounting period should be a minimum of two years. Within year progress in subsequent year-on-year reductions will be difficult to monitor given seasonal variability. The set-up of monitoring programmes to measure changes in discard rates will also take a considerable amount of time and needs to be accounted for. The regulation of any policy would be impracticable before these are put in place.

The sub-group was also concerned that one year was a very short period in which to expect fishing businesses to invest in the means of achieving the required levels of change. Capital investment, adopting new technology and developing the skills needed to apply that technology all take time. It is also unclear how businesses might respond to the demands being placed upon them. There is uncertainty as to when and how feedback on progress would be available to fishing businesses. It is important that the industry is informed as to whether targets are being achieved or if additional measures are required to achieve the target reductions. Progress could be assessed at a sufficiently small temporal scale, possibly at quarterly periods. It is important to define whether all quarters count in assessing progress or only the final accounting period for each year. Given the adjustments required of businesses and that target achievement is likely to be gradual, it is necessary to define the reporting period on which assessment is made as to whether targets have been achieved and to introduce structures that do not penalise the industry for failing to reach overall targets if the targets are being met at the end of the period.

To illustrate the point, figure 1 takes the example of the MABL targets (by number) associated with the area VII *Nephrops* fishery. The consultation document suggests that discard rates should decrease from their current level of 60% to 30% within two years. If the industry adopt a quick response to achieving the desired reductions and that this is evaluated during the second year of implementation, then this would suggest (all things being equal) that the desired reductions have been achieved with no associated follow up sanctions. However, if the industry is unable or unwilling to adopt adequate measures until towards the end of the reference period, then the cumulative achievements are far less dramatic. If the evaluation period encompasses both periods of development in reducing discards and the effect of their final introduction, then the cumulative effects are significantly lower despite the fact that the final objective has been achieved. Therefore, the period available to develop and implement mitigation tools and the period used to evaluate whether the desired reductions have been achieved should not be in conflict but sympathetic to providing adequate time to implement mitigation tools while ensuring that sufficient incentive remains to encourage achievement. These aspects need to be balanced.

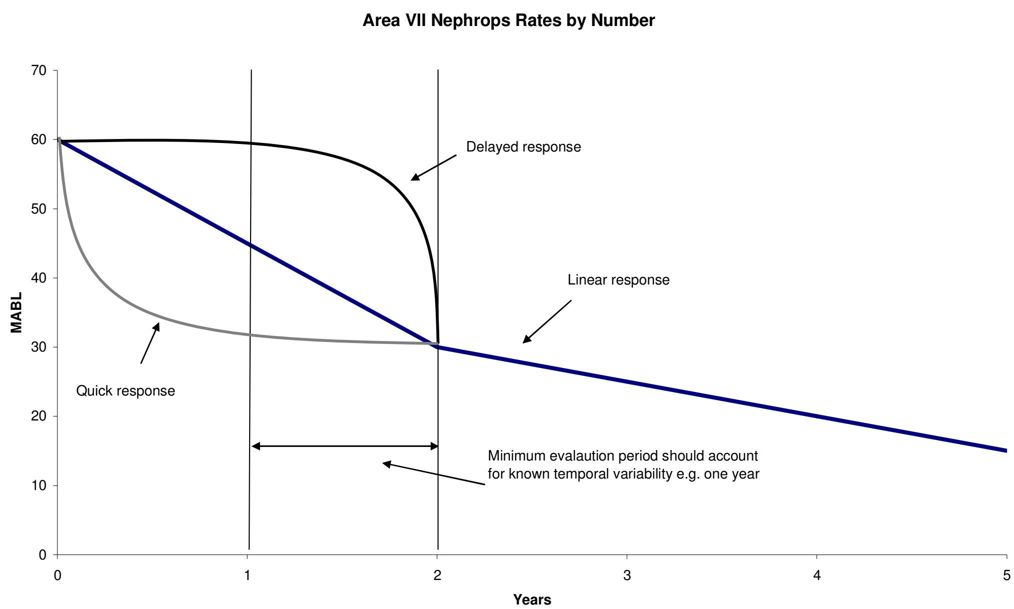


Figure 1. MABL targets for area VII Nephrops fishery

In light of all these complicating factors, and the wide variations likely between métiers in any given fishery, *the sub-group proposes that the issue of targets and the assessment of progress be subject to appropriate mid-term review involving expertise including statistical analyses. The sub-group further concludes that multi-annual rather than annual targets are more likely to be achievable from a practical perspective as this allows more time to develop and test methodologies.*

The sub-group does not feel confident in commenting on predictions or targets that are some years ahead. The evolution of technical measures makes it difficult to predict what is technically possible in any given period. Stock status can also change rapidly; recruitment for any given species tends to be cyclical and there are often 'spikes' in discard rates that reflect these changes in abundance. Such spikes in recruitment increase the possibility of failing to reach annual targets (particularly for single species indicators) with associated implications for the industry in terms of future fishing opportunities (sanctions). That said it is accepted that regulations generally do require a temporal framework within which targets must sit. The sub-group considered that there is a need for an interim review of the targets and the discard levels achieved. Based on a recent EC funded evaluation of industry uptake and development of more selective fishing methods, suggested that the period required for such advances can take in excess of two years. There should also be the possibility for member states to adopt a multi-annual approach to compliance with targets to allow sufficient time for developments. However, it is important to consider that if reductions at the required rate are only achieved at the end of a given timeframe then fishermen could be penalised for not achieving the cumulative reductions while achieving the 'goal'.

4.6. Implications for enforcement and monitoring of discards targets.

Vessel owners' decisions on whether to change practices and if so, how much money it is worth spending, depend, in the absence of any positive incentive to change, on how likely they believe it is that there will be a negative consequence of not changing and how severe such a consequence would be in relation to the cost of changing practices to reduce discards.

Business management to maximise profit by minimising costs

The cost of meeting the discards target is a business cost and consists of any direct expenditure required plus any reduction in profit resulting from lower commercial catch. A sanction applied for failing to achieve a discard target would also be looked upon as a potential business cost. The normal way of managing a business is to minimise or avoid costs and this approach is likely to be applied by vessel owners to the costs of achieving discards targets or facing sanctions for failing to do so.

Level(cost) of sanction

If the sanction is to be effective in triggering changes to practice, it must be more costly than achieving the target. If a vessel owner believes that the sanction for failing to achieve target levels will be less costly than the cost of achieving the target, then it no longer matters whether the sanction will be applied. The owner has to face one of two costs (compliance or sanction), and is more likely to take the less costly route, namely, make no change to practice and pay the sanction.

If the costs of achieving the target are uncertain, as they are likely to be in many cases, then the sanction must exceed the maximum likely estimate of costs to achieve the target if the sanction is to be viewed as the less attractive option.

Probability of incurring a sanction (cost)

If a vessel owner believes that the sanction for failing to achieve the target levels is likely to be more costly than adopting measures to reduce discards, then, assuming the owner still expects to be profitable despite the additional cost, he will next consider how likely it is that his business will incur sanctions.

If the sanctions are applied at fishery level, with no causal link to individual vessels, then each vessel owner must second-guess the actions of the other skippers in the fishery, some of whom are from different countries, in order to assess the probability that the fishery as a whole will achieve or miss the discards target. This becomes essentially a prisoners' dilemma situation. If a skipper chooses to adopt costly discard reduction practices, but not enough other skippers in the fleet do so and sanctions are applied, then the skipper who experienced the costs of compliance would also experience the costs of sanctions, whereas those who did not invest in discard reduction would suffer only the costs of sanctions. So the skipper who changes practices is penalised relative to those who did not improve their discard levels.

Vessel owners may choose to reduce discards and hope to influence others to change practice such that the fishery overall achieves the discard level targets. Alternatively, they may expect that it is unlikely that others will change practices and will decide to accept the costs of the sanction only, rather than the costs of changing practices and the costs of sanctions as well.

Therefore, if a sanction is to be effective, it must not only be more costly than changing practice to achieve the target, it must also apply specifically to vessels which do not achieve the discard targets, rather than equally to all vessels, whether or not they achieve the target.

Possible longer term outcomes and responses to the targets

Although in the immediate term, this will make the fleet less profitable than it would be without the discard targets and sanctions, there are a few possible routes to recover (or exceed) previous levels of profit. One, is that in time, possibly several years, target stock will have recovered to a level which gives a higher catch rate. Although this situation may lead to better in-year profit levels, it does not seem likely that higher catch levels will generate enough additional profit to cover the foregone profits in the interim, i.e. there is likely to be a negative NPV to adopting discard practices.

A second route is that technology will improve and generate a solution to catching with lower by-catch rates in such a way that overall profit levels are at least equal to current levels. Again, it is not possible to know whether such a solution will arise, if so when, and whether it would be able to generate enough profit to replace the profit foregone during the interim period.

A third possibility is that some vessel businesses cease trading as conditions become tougher and the reduction in vessel numbers and fleet capacity enable remaining vessels to catch more per vessel (without onerous access costs) such that each remaining vessel has improved profit opportunities.

Another possible response to the imposition of targets relates specifically to how the achievement of targets is assessed. If there is a compulsory observer system on a given proportion of trips within the fishery, then it is possible that individual skippers may take costly steps to comply with discard reduction targets only when observers are on board. In other words, they may not invest in new gear or other technology to reduce by-catch and hence discards on an ongoing basis, but may simply adopt avoidance tactics on the trips when they carry observers. This could be fishing in areas where they expect low by-catch levels and carrying back to shore any unwanted catch which cannot be discarded within with target levels. In this way, a fishery may be able to achieve the target as far as the assessment is concerned, without actually investing in an overall reduction of discards. Sanction costs will be avoided with only a loss of profit on the trips during which an observer is on board.

Further expansion of these ideas is available in the interim reports of the COBECOS project which was submitted to the Commission earlier in 2008. It includes the theory of private benefit maximisation in fisheries and models the likely level of adherence to fisheries rules depending on vessel owners' perception of probability of being caught in breach of a rule, probability of being fined and level of fine, which vary according to different levels of enforcement and fines (sanctions).

4.7. Verification of discard data

It is proposed that the discard data provided by member states should be verified by a body such as ICES. The sub-group is aware of the limited possibilities that exist in this respect given that ICES will have access to no other data than that provided by member states other than that collected under the Data Collection Regulation (DCR). It could well be that data from a fishery are only available from one métier and are intrinsically biased. In the absence of a binding requirement for data to be collected to specified standards and formats that it will not be possible to compare fleets one with another.

The clear implication here is that the requirements for data will have to be subject to careful consideration well in advance of the implementation of the scheme in order that structures, standards and appropriate training can be established. In the absence of such provisions the likelihood is that the data will be neither comprehensive nor robust. In that event the structures through which performance might be assessed and sanctions imposed could perhaps be called into question.

The sub-group concludes that centralised intervention, in the form of standards for data, analysis and training will be essential to ensure the effective and equitable application of this policy.

The sub-group accepts that the absence of data should not be used as an excuse for inaction. It does, however, emphasise that the credibility of the new initiatives on discarding will depend critically upon there being a coherent commitment to the introduction of a number of supporting structures and competences.

Table 1. Advantages and disadvantages of setting the targets for different groups of species.

	Environmental / ecological	Stock recovery / conservation	Economic / business	Practicality
All fish and shellfish species (aggregated discard rate)	**Pros**: Can assess whether the fishery is following the EAF approach?? If all species discards are reduced in proportion to previous discards, then this would give maximum environmental / ecological benefit because it maximises the reduction of discards. If a vessel owner has more options available to reach the target, then more likely to achieve the target more quickly, thus reducing waste more quickly. Could help conserve species which will be food to the commercial species in future	**Pros:** **Cons**: May not necessarily achieve benefits to stocks of particular concern if discard target is achieved by reducing discards of other species.	**Pros:** Get more choice of which species discards to reduce and therefore more flexibility which methods to choose to achieve targets. Achieving all species targets may give possibility to continue fishing in protected areas. **Cons:** A strategy to reduce discards could be to land elements of the catch rather than discard it, even though it has no market value. This would have negative financial effects as it takes up storage room on board for	**Pros:** Would be easy to count / record a total volume of discards if there is no requirement to split by species. **Cons:**

	Cons: Fishers may focus on reducing catch of most discarded species only in order to achieve overall reduction and this may not have any benefit on some key species whose by-catch levels are not reduced. Cannot tailor the approach to suit each fishery Cannot forecast what the resulting proportion of species in discards will be because unlikely to be proportionately reduced across all species.		no or lower sales value. Possible that any technical measure that would deliver the target would not catch enough fish of value to make fishing profitable.	
Indicator species	**Pros:** Could take a tailored approach to every fishery Could include particularly vulnerable species and focus the improvements on the species that matter most	**Pros:** Can select species of concern from a stock recovery point of view. **Cons:**	**Pros:** Would increase future revenues if species are well selected **Cons**:	**Pros:** easier to achieve initially, more likely to succeed.

	Cons: Measures to reduce discards will be designed only to achieve reductions in the indicator species and other species may continue to be discarded. This could be vulnerable to fraud and if so, would not have desired ecological effects.	This could be vulnerable to fraud and if so, then would not have desired stock conservation effects. **Caveats:** Need to be careful that chosen indicator species are representative of the entire fishery		**Cons:** complexity – may require different targets for each métier within a fishery.
Only commercial species (if MLS are reduced then different pros and cons would arise)	**Pros:** **Cons:** May give no benefits or impossible to measure benefits to non-commercial species	**Pros:** Maximises benefit to commercial stocks and speeds up stock recovery **Cons:**	**Pros:** Would increase future revenues **Cons:** Reduce possibility to high grade	**Pros:** Easier to implement **Cons:** Species which fall into this category change over time and from one region to another
	Environmental / ecological	Stock recovery / conservation	Economic / business	Practicality

5. DESCRIPTION OF THE FISHERIES

5.1. Bottom trawling targeting *Nephrops* in ICES Area VII

Area VII *Nephrops* are managed as 7 Functional Units (FUs). Each of these can be prosecuted by separate métiers based on nationality, gear type, mesh size, trip length and main target species. *Nephrops* are exploited by vessels from France, Spain, UK and Ireland. A summary of the Area VII métiers is given in table 2; the fishing grounds are shown in figure 2.

The non-paper is unclear in its definition of what constitutes a targeted *Nephrops* fishery and Member States also work with different definitions. The UK and Ireland use 30% *Nephrops* by weight of retained catch; France uses 30% by value of retained catch. Spain, whilst deemed to take "the majority of landings" in VII b, c, j, k (ICES 2006a) appears not to have a targeted fishery for *Nephrops*.

A further caveat must be added to these uncertainties which relates to the general quality of data available for these fisheries. Neither catch profiles nor discard rates are comprehensively available and this could lead to great difficulty in setting equitable benchmark figures (starting points) for the various métiers. Currently published figures range from 1% (France, undefined, Areas VII b, c, j, k) to 25% *Nephrops*/43% all species in VIIb.

In 2006 ACFM reported that, "in FU16 (Porcupine Bank), the available data indicate increased targeting of *Nephrops* over the last two years by all countries involved in the fishery." (ICES, 2006b)

Métier description	Discard problems	Comments
Irish Sea: single rig otter trawler, UK, Ireland	Whiting, cod, haddock, plaice, *Nephrops*, dab, witch, megrim, pout, gurnards, dragonets	See table 2 for further details of Irish métiers
Irish Sea: twin rig otter trawler, UK, Ireland	Whiting, cod, haddock, plaice, *Nephrops*, dab, witch, megrim, pout, gurnards, dragonets	Discarding rate similar to single rig but higher absolute catch rate
Porcupine: single/twin rig otter trawler, Ireland	Hake, anglerfish, megrims	
Porcupine: single/twin rig otter trawler, France	*Nephrops*	

Aran grounds: Ireland	Cod, haddock, anglers, megrim	
Celtic Sea: single/twin rig otter trawl, Ireland	Megrims, hake, ray spp, witch, anglers	
Celtic Sea: single/twin rig otter trawl, France	*Nephrops*	

Table 2 General overview of the Nephrops métiers operating in area VII.

5.1.1. The Irish Nephrops fishery in ICES Sub-area VII

In general, the Irish *Nephrops* fleet is comprised of two types of vessel – older single-rig or twin-rig wooden vessels, typically Scottish built and newer steel-hulled twin-rig vessels, typically French built.

Smaller single rig vessels (10-16m LOA) are on the decrease and these vessels usually carry out one-day trips on inshore grounds.

The twin rig fleet (17-26m LOA) are larger, better equipped vessels, allowing them to travel further and stay at sea for longer periods in heavier weather. However, increasing fuel costs have prompted some of these vessels to switch to single-rig fishing, which causes less drag in the water and as a result, uses less fuel. Twin-rig vessels usually fish 4-7 day trips. Many vessels operate relief skippers and crews to maximise fishing time and earnings.

The Irish *Nephrops* fleets are highly opportunistic, and frequently move around the coast as fishing opportunities and market forces dictate.

A part of the Cod Recovery Programme, a section of the Irish Sea is closed to fishing in the spring. *Nephrops* vessels can obtain a derogation to fish in certain sections of this closed area, provided they fit a separator panel to their gear. Rather than comply with these regulations, many vessels re-direct effort to the Eastern Irish Sea, Smalls or Porcupine grounds.

Analysis, by the Irish Marine Institute, of landings compositions from Irish vessels has identified eight métiers in the Irish *Nephrops* fleet operating in ICES Area VII (see table 3). Worth noting is the marked increase of vessels in the Porcupine grounds (VIIc & VIIk) – this reflects the introduction of large, well-equipped vessels into the fleet which target the Porcupine grounds fishery for better quality product.

	2003		2004		2005		2006		2003 relative % change	
Metier Name	No. Trips	No. Vessels	No. Trips	No. Vessels	No. Trips	No. Vessels	No. Trips	No. Vessels	No. Trips	No. Vessels
Clean Nephrops OTB VIIa	755	52	895	39	822	41	837	49	11	-6
Mixed Nephrops OTB VIIa	379	51	323	44	393	52	318	50	-16	-2
Clean Nephrops OTB VIIb	110	21	57	18	148	22	106	31	-4	48
Mixed Nephrops OTB VIIb	215	30	167	23	164	28	141	32	-34	7
Clean Nephrops OTB VIIg	396	61	284	55	511	82	446	72	13	18
Mixed Nephrops OTB VIIg	427	59	445	66	545	80	584	73	37	24
Nephrops OTB VIIc & VIIk	43	11	72	15	160	24	156	32	263	191
Nephrops OTB VIIj	227	30	172	43	201	38	223	40	-2	33

Table 3. Irish Nephrops métiers in ICES Area VII showing the number of commercial fishing trips and number of vessels in each métier from 2003 to 2006. “Clean Nephrops” are vessels reporting >~80% Nephrops by weight in the landings and “Mixed Nephrops” are vessels reporting >~35% Nephrops by weight in the landings.

The Irish Fishery by ICES Sub-Area:

VIIa (Irish Sea)

There are two main *Nephrops* fishing grounds in the Irish Sea: Irish Sea west and Irish Sea east – Irish Sea west is more important to the Irish *Nephrops* fleet

The *Nephrops* fishery is Ireland's most important demersal trawl fishery in VIIa

The fishery peaks around June-August.

Due to the small mean size of Irish Sea *Nephrops*, landing of *Nephrops* tails for processing as the value-added product "scampi" is an important source of revenue

Vessels from Clogherhead, Skerries, Balbriggan and Howth primarily target this fishery

Bycatch includes cod, haddock, plaice, anglerfish, ray

Total *Nephrops* landings by Irish vessels from VIIa amounted to ~3,000t in 2007

VIIg (Smalls, Labadie)

The Smalls fishery is the most important *Nephrops* fishery to the Irish fleet in terms of volume of landings.

Vessels from Clogherhead, Howth and Dunmore East primarily target this fishery

The fishery peaks around April-June

Vessels from Clogherhead and Howth tend to land tailed and whole *Nephrops* from this fishery, while vessels from Dunmore East tend to land the product whole.

Bycatch includes cod, haddock, plaice, whiting, anglerfish, lemon sole, megrim

Vessels fishing VIIg may switch to seining during the summer months to avail of the longer daylight hours, reverting to *Nephrops* fishing during the winter when shorter days restrict the ability to seine

Total *Nephrops* landings by Irish vessels from VIIg amounted to ~3,850t in 2007

VIIj (South West)

This is a more localised, inshore fishery based on smaller, discreet fishing grounds

Nephrops are landed as part of a more mixed fishery and *Nephrops* landings are highest during the summer

Bycatch includes cod, haddock, anglerfish, hake, megrim

Vessels from Union Hall, Dingle and a host of smaller ports target this fishery

Vessels fishing VIIj may switch to seining during the summer months to avail of the longer daylight hours, reverting to *Nephrops* fishing during the winter when shorter days restrict the ability to seine

Total *Nephrops* landings by Irish vessels from VIIj amounted to ~268t in 2007

VIIb (Back Of Aran)

Targeted primarily by vessels from Ros-a-mhíl

Bycatch includes cod, haddock, anglerfish, megrim

Nephrops are landed whole and tailed

The fishery is at its best from April-June and from October-November.

Total *Nephrops* landings by Irish vessels from VIIb amounted to ~951t in 2007

VIIc/k (Porcupine)

High value fishery based on landing of large, good quality, whole *Nephrops*

Bycatch includes anglerfish, hake, megrim

Generally fished by larger vessels, which have the ability to stay at sea for long periods. Many vessels fishing the Porcupine Bank have installed freezer systems allowing the *Nephrops* catch to be frozen on-board. The resulting product is of a higher quality and fetches a higher price on the market

This fishery peaks around April-June

Vessels from Clogherhead, Howth, Dunmore East, Union Hall, Dingle and Ros-a-mhíl primarily target this fishery

Many vessels fishing the Porcupine Grounds will target either anglerfish or *Nephrops* or a combination of both as fishing or market opportunities dictate

Total *Nephrops* landings by Irish vessels from VIIc/k amounted to ~1,000t in 2007

5.1.2. UK (Northern Ireland) Nephrops Fisheries in Sub-Area VII

The *Nephrops* fishery is Northern Ireland's most important demersal trawl fishery in VIIa. The fishery concentrates on both the eastern Irish Sea (FU14) and western Irish Sea (FU15) fishing grounds. Northern Ireland landed approximately 65% of the total international landings from FU15 in 2007, making this the most important fishing ground for the fleet. Towards the end of 2007 there were 113 over 10 meter vessels targeting *Nephrops* in the Northern Irish fleet.

Vessels are either single or twin rig. Single trawl vessels normally do 1-2 day trips of 3-4 hour tows while twin-trawl vessels stay at sea for 3-5 days and do tows of 4-12 hours duration. Landings are into the three traditional Northern Ireland ports of Kilkeel, Ardglass and Portavogie, or primarily Whitehaven if operating in FU14. Historically, *Nephrops* were landed into Northern Ireland as tails only and sold to supply the lucrative 'scampi' industry for consumption at home and abroad. The scampi industry requires a sustained supply of small *Nephrops*. In the last 15-20 years, however, the trend has been towards landing whole large *Nephrops* for the export market.

A characteristic of this fleet in the last 3 years is an autumn migration of vessels from Kilkeel to explore more profitable *Nephrops* grounds in the West of Scotland and North Sea. This has the effect of further reducing effort in the Irish Sea from September through to December

5.1.3. UK (English and Welsh) Nephrops Fisheries in Sub-Area VII

The English and Welsh component of the fisheries targeting *Nephrops* norvegicus in Sub-Area VII, is limited to the eastern side of division VIIa, the eastern Irish Sea . The resident fleet is small and consists of approximately 20 vessels that operate out of Whitehaven, Maryport, and Fleetwood. The number of vessels operating from these ports can alter significantly when the *Nephrops* fishery is successful. Vessels who generally operate out of Northern Ireland, Ireland and the north east coast of England, but who will take advantage of a good fishery when it occurs, join the resident fleet targeting *Nephrops*.

Resident vessels switch between targeting *Nephrops* or finfish depending on the season. *Nephrops* start appearing in the catches in March/April and increase in abundance through the summer months, with the fishery ending in the autumn. During the season though the *Nephrops* are not always available and can disappear from the fishing grounds overnight, into their burrows. Visiting vessels usually leave the area and the resident vessels will switch to a finfish trawl. The *Nephrops* fishery uses predominantly single rig otter trawl nets with 80mm codend and a square mesh panel in the top of the net. The finfish trawl is usually a single rig otter trawl with 100mm codends and is used to target Plaice (*Pleuonectes platessa*) and mixed ray species (*Raja spp*.).

Resident vessels generally limit themselves to the waters to the east of the Isle of Man when fishing for *Nephrops* and can occasionally travel further when targeting finfish. The size of these vessels is less than 24m overall length and trips rarely exceed 48 hours duration, with most boats operating on a day trip basis. In recent years the average length of the resident vessels has decreased and most vessels are now less than 15m overall length.

The low fishing effort by English registered vessels in the Irish Sea directly impacts on the current sampling programme under the DCR, because the sampling plan is based on activity, gear type and region. The fishing effort of the corresponding quarter of the previous year is used to stratify the available sampling time between all of the UK's port areas and gears. This results in very low sampling of the Irish Sea fisheries. In 2005 the targeted number of days at sea was 4 days on *Nephrops* trawls and we achieved 6 days sampling. In 2006 the target on *Nephrops* trawls was 2 days and we achieved 2 days. However in 2007 sampling increased, in part due to the new self-sampling project requiring an increase in Irish Sea observer coverage by an additional 50% and part in due to some other gears being removed from our sampling programme, giving *Nephrops* trawl a higher priority. This led to 36 days being the target and we achieved 32 days on *Nephrops* trawls.

The poor data in the earlier years renders this information unusable, however the 2007 data is much improved and should have some useable value.

Catch reports for individual trips show that the main retained species by number in the *Nephrops* fishery are *Nephrops*, Plaice, Mixed Rays, Brill, Turbot, Cod and Sole. The main discarded species by number being *Nephrops*, Dab, Plaice, Whiting and mixed Gurnards. This is also the situation when the English data is aggregated for all sampled *Nephrops* trips.

5.1.4. French fisheries for Nephrops in Area VII

French effort in area VII is concentrated in Divisions f, g, h (*Nephrops* Area M) and b, c, j, k which covers the Porcupine Bank.

In Area M (the Celtic Sea) the French fleet historically landed 80-90% of the total *Nephrops* catch but this proportion has fallen to 50-60% in recent years. Since the beginning of 2000, the French fleet use a minimum mesh size of 100mm and the POs operate a minimum landing size of 35mm CL compared to the EU MLS of 25mm CL. This difference in MLS has resulted in strong discarding above 25mm. There are recent indications that discard rates on small *Nephrops* have fallen but the reasons for any such change are not clear.

ICES Southern Shelf WG (ICES, 2006a) has pointed out that "there are concerns about increasing efficiency of the French fleet. Discarding is substantial, but varies between fleets and areas"

French discard data are available for a few years only, the most recent published being 1997.

	Weight	Number
Global discard rate	55 %	
Nephrops discard rate	35 %	62 %

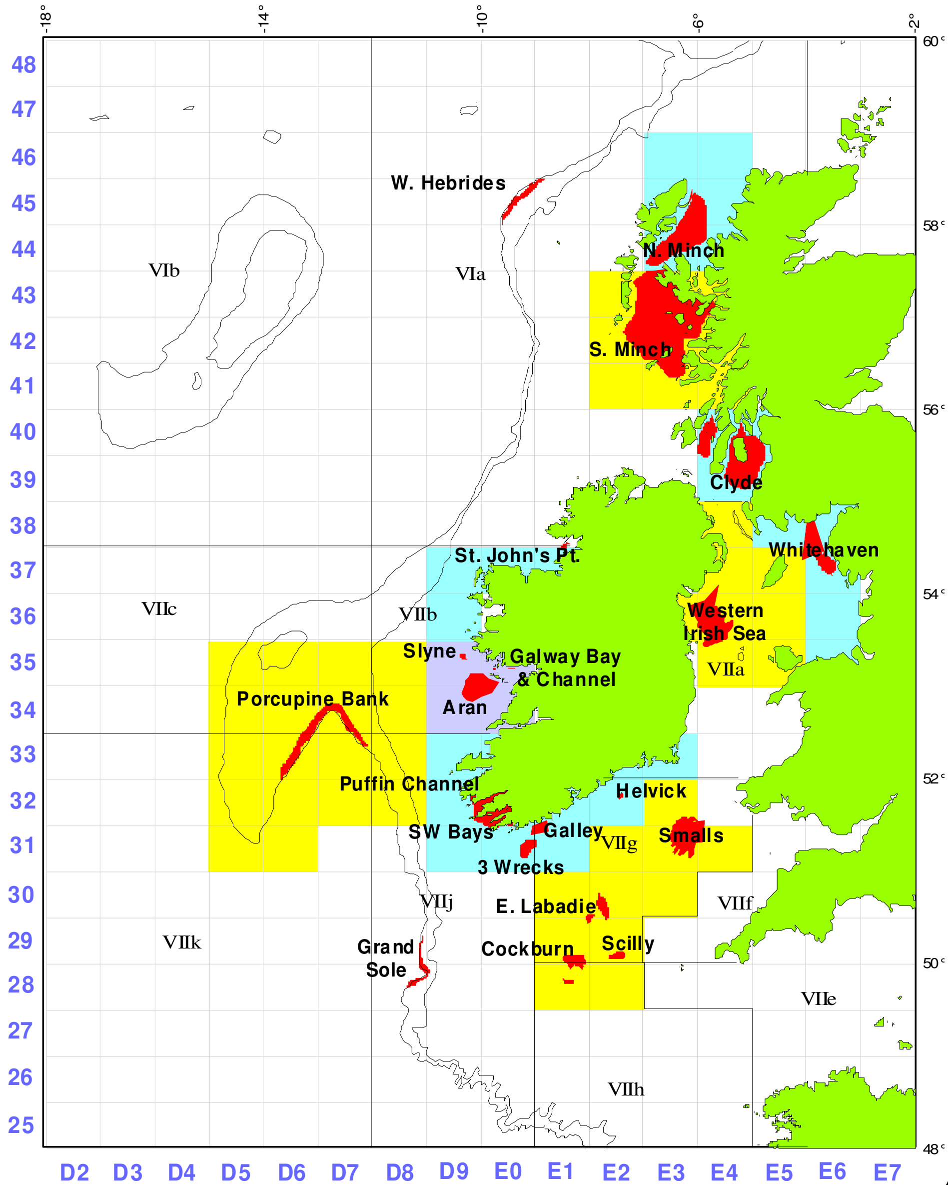
ICES (ibid) comments that "more frequent discard samplings of the French fleet would greatly improve the quality of length/frequency data."

A part of the French fleet operates also on the Porcupine Bank and XIV reported landings >10t. The sizes of *Nephrops* taken on these grounds tend to be higher than elsewhere. The French fleet fishing *Nephrops*' in VII is estimated to 96 vessels in 2006, among them 72 are considered to really targetting this species in Area M and around 20 in Porcupine Bank.

It is not known how many vessels in the French fleet would fall within the non-paper's definition of 'targeting *Nephrops*'

5.1.5. Spanish fisheries for Nephrops in Area VII

Spanish effort in Area VII probably does not fall within the non-paper's definition of 'targeting *Nephrops*'.



Annex

Figure 2 Location of Area VII Nephrops fishing grounds

5.2. Beam trawl fisheries for flatfish in areas IV and VIId

5.2.1. Belgium beam trawl fisheries

This section contains a brief description of the Belgian sea fisheries and its most important features.

Fleet size and fleet segments

In 2005, the Belgian sea-going fishing fleet comprised 124 registered vessels (see text and table 4 below).

Operational fleet segment	Hp class < 300	301-600	601-900	901-1200	> 1200	**Total**
Beam trawlers	43	1	7	30	21	**102**
Whitefish and *Nephrops* trawlers	6	--	2	--	--	**8**
Shrimp trawlers	11	--	--	--	--	**11**
Static gear	--	2	1	--	--	**3**
Total	**60**	**3**	**10**	**30**	**21**	**124**

Table 4. Composition of the Belgian sea-going fishing fleet in 2005.

Broadly speaking, the Belgian fishing fleet can be sub-divided into the following fleet segments:

Mid-class (301-900 Hp) and large (> 900 Hp) beam trawlers. These vessels are mostly flatfish directed, particularly towards plaice (*Pleuronectes platessa*) and sole (*Solea solea*), together with the associated by-catch species such as turbot (*Psetta maxima*), brill (*Scophthalmus rhombus*), dab (*Limanda limanda*), lemon sole (*Microstomus kitt*), anglerfish (*Lophius spp.*) and some roundfish. This fleet segment usually operates in the central and southern North Sea (ICES Sub-areas IVb and IVc), the English Channel (VIId and VIIe), the Irish Sea (VIIa), the Celtic Sea (VIIfg) and the inner part of the Bay of Biscay (VIIIab).

Small beamers with engine powers ~ 300 Hp. Part of these primarily target flatfish, mostly in the southern North Sea and the eastern Channel. Others shift between flatfish, brown shrimp (*Crangon crangon*) (in the coastal waters) and Norway lobster (*Nephrops norvegicus*) (usually in the Botney Gut - Silver Pit area, southern North Sea), depending on catch opportunities and market prices.

A small number of *Nephrops* directed and mixed whitefish-*Nephrops* trawlers. Most of these vessels use multi-rig otter trawls. The *Nephrops* trawlers mostly fish in the Botney Gut - Silver Pit area (southern North Sea). The mixed whitefish-*Nephrops* trawlers target roundfish (primarily cod, haddock, whiting, and occasionally saithe) during part of the year, and *Nephrops* during the main *Nephrops* season (3rd and beginning of 4th quarter).

Approx. 10 shrimp trawlers, targeting brown shrimp (*Crangon crangon*) in the Belgian and Dutch coastal waters. Sometimes, these vessels land their catches directly into the Netherlands.

A small number of catamarans, using different types of static gear.

Apart from the registered vessels, there is a relatively small number (allegedly < 50) of ***non-registered*** recreational fishing boats. Most of these target brown shrimp in the shallow near-shore waters, close to their homeports. Recreational fishing for brown shrimp is strongly weather dependent and is usually restricted to the summer months.

Areas fished

Landings by the Belgian sea-going fishing fleet are primarily from the North Sea (43 % of the total landings in 2005), followed by the English Channel (24 %), the Celtic Sea (18 %), the Irish Sea (11 %) and the Bay of Biscay (2 %). Landings from other areas (South of Ireland, West of Scotland, etc.) are small to negligible.

Species landed

Belgium has no industrial and no pelagic fisheries. All fish and shellfish landed by Belgian vessels is for human consumption. The consequence being, that the quantities landed are relatively small (21.7 10^3 t in 2005 – a roughly 10 % decrease over the 2004 figure of 23.6 10^3 t) compared to the size of the fleet, but also that their value per kg is relatively high (approx. 3.65 Euro/kg – average for 2004).

In 2005, the top 10 of the most important species landed (by weight) consisted of plaice (22.3 % of the total landings), sole (19.4 %), rays (8.9 %), cod (8.1 %), lemon sole (5.1 %), brown shrimp, cuttlefish, dab, tub gurnard and scallop. Table 5 gives an overview of the Belgian landings by species (in 2005).

Landing and auctioning practices

Fish and shellfish landed into Belgium are landed fresh and chilled (kept on ice but not frozen). At sea, fish and shellfish are commonly sorted by species or species groupings (e.g. cod, haddock, whiting, sole, plaice, rays, small sharks, *Nephrops*, mixed other flatfish and mixed other roundfish), but not by size. Size grading is done in the auction, either by hand or by automated grading machines.

If the quantities are sufficiently large, then individual species are auctioned separately (and for most species also by market category). Marginal by-catches of whatever species are often auctioned as 'mixed assortments'. Mixed sales are also the rule for most species of ray, for megrim, anglerfish, squid and octopus, and, depending on the quantities landed, for gurnard.

Species or species group	**ICES Sub-area or Division**							
	IV	VIIde	VIIa	VIIfg	VIIhjk	VIIIab	Other	Total
Anarhichas lupus	110	--	--	--	--	--	< 5	110
Aspitrigla cuculus	30	185	10	45	< 5	< 5	--	280
Conger conger	< 5	25	10	25	--	< 5	--	65
Dicentrarchus labrax	35	15	< 5	20	--	--	--	70
Eutrigla gurnardus	15	15	--	5	--	< 5	--	35
Gadus morhua	1405	65	90	160	< 5	--	35	1755

Hippoglossus hippoglossus	< 5	--	--	--	--	--	--	< 5
Lepidorhombus spp.	< 5	5	5	125	10	5	--	150
Limanda limanda	350	105	30	45	--	--	< 5	535
Lophius spp.	70	60	40	200	5	60	< 5	435
Melanogrammus aeglefinus	160	< 5	20	135	< 5	--	< 5	320
Merlangius merlangus	85	45	10	185	< 5	< 5	--	325
Merluccius merluccius	55	--	5	10	--	10	5	80
Microstomus kitt	550	95	20	425	< 5	--	15	1105
Molva molva	25	10	< 5	40	< 5	--	--	80
Mullus surmuletus	10	25	--	10	--	5	--	45
Mustelus mustelus	5	5	< 5	< 5	--	--	--	15
Platichthys flesus	225	40	15	< 5	--	--	--	280
Pleuronectes platessa	2910	1105	485	250	10	< 5	45	4805
Pollachius pollachius	20	35	10	40	< 5	--	< 5	110
Pollachius virens	25	--	--	< 5	--	--	--	25
Psetta maxima	145	65	45	85	--	5	< 5	350
Rajidae	310	125	760	710	< 5	10	5	1930
Scophthalmus rhombus	110	130	45	75	< 5	5	< 5	375
Scyliorhinus canicula	85	170	90	130	< 5	10	--	495
Sebastes spp.	< 5	--	--	--	--	--	--	< 5
Solea solea	1250	1195	580	740	70	355	< 5	4190
Squalus acanthias	< 5	< 5	5	10	--	--	--	20
Trigla lucerna	60	335	65	40	--	5	--	510
Trisopterus luscus	25	220	5	50	< 5	5	--	300
Other demersal species	35	110	30	150	< 5	20	--	350
Clupea harengus	5	--	--	--	--	--	--	5
Scomber scombrus	< 5	--	--	--	--	--	--	< 5
Sprattus sprattus	--	--	--	--	--	--	--	0
Trachurus trachurus	5	--	--	--	--	--	--	5
Other pelagic species	--	--	--	--	--	--	--	0
Cancer pagurus	100	40	10	50	--	5	--	205
Crangon crangon	780	5	--	--	--	--	--	780
Homarus gammarus	< 5	< 5	--	--	--	--	--	< 5
Nephrops norvegicus	165	--	< 5	5	--	--	--	170
Buccinum undatum	75	35	20	10	--	--	--	140
Loligo spp.	20	35	< 5	15	--	--	--	70
Octopus spp.	< 5	< 5	< 5	15	--	< 5	--	20
Pecten maximus	10	350	20	115	5	< 5	--	500
Sepia officinalis	60	475	< 5	45	15	< 5	--	600
Other shellfish species	--	< 5	< 5	< 5	--	--	--	5
Total	**9335**	**5125**	**2455**	**3985**	**130**	**515**	**115**	**21660**
% of Grand total	**43**	**24**	**11**	**18**	**< 1**	**2**	**< 1**	--

Table 5: Belgian landings by species and area in 2005 (all figures in t landed weight, rounded to the nearest 5 t).

5.2.2. Netherlands beam trawl fisheries

The beam trawl fishery is active the entire year through. The average duration of a trip is four to five days. The vessels are equipped with beam trawls. The nets are dragged with a speed of 6 nautical miles per hour over the bottom of the sea. Target species are valuable flat fishes like dover sole, plaice, turbot and brill. By-catch consists of other demersal fish species and benthos. The fleet can be divided in two different métiers: beam trawlers with engines larger than 300 HP (with a maximum of 2000 HP) en beam trawlers with engines smaller than 300 HP (“eurokotters”). Both métiers use 80 and 100 mm mesh-sizes. Number of vessels above 300 HP in 2006 was 107.

Quantitative information on fleets:
Fishery: Beam trawl
Mesh-size: 80 mm
Target species: Dover sole
HP: >300 to 2000
Area: IV a,b,c (27.4 a,b,c).
Fleet effort:

Year	D.A.S.
2004	20,733
2005	20,487
2006	13,686

Fishery: Beam trawl
Mesh-size: 100 mm
Target species: Plaice
HP: >300
Area: IV a,b,c.
Fleet effort:

Year	D.A.S.
2004	527
2005	584
2006	n.a.

5.2.3. French beam trawl fisheries

The French beam trawl fleet mainly operates VIId and IV, with less activity in IV. The fleet comprises of around 50 vessels (generally < 18 m). They work in the Bay of Seine (Cherbourg) and in the Bay of Somme (between Dieppe and Boulogne). The activity is not comparable with that in the North Sea because beam trawl due to differences in the size and weight of the gear operated.

5.2.4. German beam trawl fisheries

The German fleet targeting flatfish in the North Sea is consisting of different sub-fleets. Targeting predominantly sole, 7 beam trawlers with more than 300hp are operating mostly in the southern North Sea. To protect juvenile fish these trawlers are excluded from fishing in the plaice box, an area near to the coast along the Netherlands, Denmark and Germany. App. 15 smaller beam trawlers and 20 other cutters (mostly using twin trawls) with less than 300hp are working in the central and southern North Sea. The beam trawlers are targeting plaice and sole while the other cutters are operating in a mixed demersal fishery. These cutters are so-called eurocutters with lengths just under 24m which are able to use otter trawls as well as beam trawls. All vessels work all year round. In 2006 the approximate fishing (catch) time of beam trawlers >300hp were 13000 hours, the fishing time of beam trawlers <300hp were 16500 hours/year.

6. ESTIMATION OF DISCARD RATES BY FISHERY (TOR 2)

In the Commission consultation paper, baseline levels of current discard rates for the two fisheries are presented. Considering a lack of definition, the sub-group assumed that these rates are based on the aggregated catches of all fish and shellfish species combined i.e. excluding benthos and partially processed catch e.g. prawn heads or other organic remains. Under the recent data call in support of the sub-group work, Member States with activity and sampling programmes active in the two fisheries were requested to provide discard and landings data by weight and number from observed trips during the period 2005 – 2007. The objective of this was to provide estimates of aggregated discard rates across all fish and shellfish species with the initial baseline levels identified in the discussion paper and to identify the discard rates of individual commercial and non-commercial species.

6.1. Baseline Estimates

6.1.1. Data considerations

Discard rates by both weight and number were derived from data on weight and length (number) of landings and discards submitted for the period 2005 to 2007. Data were received from Ireland, UK (England Wales & Northern Ireland) and France for the *Nephrops* VII fishery, and from The Netherlands, Belgium, Germany and France for the VI and VIId beam trawl fishery. Data outputs from the JRC database were validated through comparison with individual data sets and no errors were found.

While these present the best available information, there are a number of issues that need to be considered in terms of precision and representativeness. In general, the data submitted were not collected for the purpose of establishing overall discard rates across all species for the respective fisheries and as such, could be inappropriately used. Furthermore, current sampling levels and, to a certain extent, sampling strategy is not consistent with setting baseline estimates of present discard rates for all species. These data can provide best estimates but are highly variable associated with low sampling coverage and natural variations in each fishery. Data obtained from observers is typically less than 1% of the total effort engaged in a particular fishery. In addition, data collected under the current DCR, necessitates the aggregation of data to such a level that obtaining structured discard and associated raising metrics is not possible across métiers engaged in the same fishery. From the fisheries descriptions given in section 5, it is clear that within both fisheries, a number of distinct métiers exist. Anon (2007) demonstrated that these can have distinctly different discard rates. Aggregating un-raised data across a range of métiers assumes that the sampling coverage is proportional to the level of métier activity or catches. It is not possible to assume that this is the case due to a lack of métier specific raising metrics.

The current degree of aggregation of economic data also precludes an in depth analysis of what particular interventions to reduce discard at a métier level may or may not be economically sustainable. In order to fully evaluate the success of the policy post introduction, it is necessary to ensure that data is collected on an adequate resolution to ascertain the discard rates by métier, and to evaluate the implications at a métier and species level, appropriate raising metrics, based catch and/or effort data, and information of gear, mesh size and additional technical adaptations e.g. a square mesh panel and associated technical description would also be required to assess the impact of differing measures. .

For area VII *Nephrops* fisheries, it was not possible to derive baseline estimates from catch data aggregated across all species (fish + shellfish) due to incompatibility of the design of sampling programmes which are designed for different purposes. The discard data submitted to the SGMOS from France, UK and Ireland originated from various national discard sampling programmes and includes data collected under the Data Collection Regulation. These sampling programmes were initiated and designed to gather information to estimate discard numbers at age for single species stock assessment purposes. The data, thus, have serious limitations in attempting to estimate discard rates across all species. Furthermore, considering the known difference in discard rates within métiers and by area, using such data would be inappropriate.

Data limitations from the different programmes submitted, include data where only the fish component of the catch were measured, only the discarded fish proportion of the catch measured for number and length information, or only the *Nephrops* proportion of the catch measured. This is not a reflection of poor sampling design, but rather an artefact of using data from sampling programmes with different objectives. Out of a total of 253 trips for which number data were available for 2005-2007, only 41 trips have both fish and corresponding *Nephrops* measurements. This is an insignificant proportion of the overall number of fishing trips over three years for the whole of Area VII. Consequently, spatial coverage are exceptionally poor and the data originate from small *Nephrops* fishing grounds that have discard rates known to be different to the main fishing grounds. To use the data for establishing a global baseline discard rate for the entire fishery would be entirely inappropriate.

Due to differences in the number of species sampled by one member state in contrast to the other major participants in the beam trawl fishery, it was decided to exclude these data when deriving the overall (across species) discard rates. The data is included for deriving the discard rates at a species level.

Considering the caveats articulated above, analysis of the data submitted for the purpose of the meting provides point based estimates of discards. These are based on rates aggregated across three years by number, weight and species and over several métiers. These spatial and temporal distinctions are likely to have different discard patterns by species composition and age structure and failure to consider this at a sufficient resolution can result in incorrect inferences being drawn as to the level of discards and can obscure the true pattern of discarding. As the estimates given here are solely based on data from sampled trip and not raised to a métier or fleet level, the sampling programme is assumed to cover all fleets operating within the broader fishery definition without bias. To provide a better picture of discarding within the fishery, data collection should be conducted at a métier level with corresponding auxiliary data for raising purposes.

In the absence of concurrent sampling (specified under future DCR), the basis of the discard rate estimates by number is reduced as the landed component in a number of trips was weighed but not measured, making it impossible to provide estimates of discards by number.

Given the limitations noted above, a comparison of the baseline levels by weight and number between the initial non-paper estimates and those obtained from the data collected for SGMOS 08-01 are given in table 6. For the beam trawl fishery, the data presented to SGMOS 08-01 suggests that the *initial baseline levels underestimated the discard rates in terms of numbers and overestimated the discards by weight. It is not possible to contrast the baseline levels for area VII*

Nephrops due to the issues outlined above, but it is clear that discarding rates for both fish and Nephrops are high.

	Discards Rates by weight	Discards Rates by Number
IV/VIId Beam trawl	55%	89%
Consultation paper	*70%*	*80%*
VII *Nephrops* (fish)	64%	88%
VII *Nephrops* (*Nephrops*)	29%	44%
Consultation paper	*50%*	*60%*
(Combined)r		

Table 6 Comparison of overall discard rates derived from discards data collected from 2005 to 2007 with the initial baseline levels laid out in the consultation document.

Discard rates of commercial species associated with the area IV and VIId are given in table 7. It should be noted that while these indicate the relative discard rates, they do not provide any information on the overall contribution that they may have to mortality. It is clear that discard rates associated with almost all the commercial species are high. It is not possible to present data on the discard rates relative to the overall catch due to the differences in sampling strategy noted above. Discard rates of non-commercial species are 100%.

Species	Discard rate by number	Discard rate by weight
European plaice	75.9	38.1
Common sole	26.7	12.2
Common dab	97.6	83.8
Haddock	3.4	3.5
Atlantic cod	74.3	50.8
Whiting	94.9	72.5
Turbot	3.5	0.5
Norway lobster	70.2	15.9
European flounder	69.7	44.8

Angler (Monk)	11.1	2.1
Brill	19.1	1.2
Grey gurnard	99.6	97.6
Red gurnard	81.2	63.2
Lemon sole	99.4	16.4

Table 7 Discard rates by number and weight of the main commercial species associated with the IV and VIId beam trawl fisheries.

Estimates of discard rates for the main commercial species associated with the area VII *Nephrops* fishery are presented in table 8. Discard rates by weight and number are presented in two ways, relative to landings of individual species and relative to the total catch of fish. This allows the relative overall contribution of a particular species and demonstrates that for the trips sampled, whiting constitute almost 20% of the total fish discards implying that any mitigation method that reduces the retention of whiting will help considerably in achieving the initial target reductions outlined in the consultation paper.

	Discard rates by weight		Discard rates by number	
	By species	By total fish	By species	By total fish
Nephrops	29	NA	44	NA
Whiting	72	0.76	84	19.07
Haddock	81	0.00	88	4.50
Angler(=Monk)	13	0.02	52	0.73
Atlantic cod	11	0.00	51	0.22
Megrim	27	0.48	57	2.53
European plaice	76	0.15	93	5.75
European hake	54	0.01	83	1.63
Angler (Monk)	1	0.28	34	0.02

Table 8 Discard rates by number and weight of the main commercial species associated with the area VII Nephrops fisheries.

6.2. Selection Indicator species for the two fisheries

Plaice and *Nephrops* are suggested as candidate indicator species for the IV/VIId beam trawl and area VII *Nephrops* respectively. In addition, due to the recovery status of cod in each area, cod should be considered as an additional indicator species. These should all be subject to reductions at the same rate as discard rates targets for all species combined. The selection of these species is based on expert knowledge of the fisheries and the sub-group considered that these should be selected on the basis that they encompass the entire fishery as defined in the consultation paper and are caught and discarded in significant quantities across all métiers within the fishery. The sub-group were unable to identify any other individual (fish) species that are indicative of the entire area VII *Nephrops* activity due to its wide spatial coverage. It is also suggested that within a particular fishery, all species subject to recovery plans be included as a target with the same reduction targets.

7. TECHNICAL MEASURES AVAILABLE TO REDUCE RETENTION OF UNWANTED CATCH

7.1. *Nephrops* fishery in VII

There are numerous gear designs that are employed or have being tested in the *Nephrops* fisheries that aim to reduce bycatch (see Graham and Ferro, 2004 and Catchpole and Revill, 2007 for review). These trawl designs have used a multitude of design features, differing in size, construction material and positioning within the net. The following is a summary of gear modification that have been employed and have being broadly categorised into five types: Separator grids; separators and guiding panels; square mesh panels; capture avoidance designs; and codend modifications. While these bycatch mitigation devices have being tested on their own they have also being used in combination with each other in many different arrangements.

7.1.1. Separator grids

The use of grids to improve trawl selection depends little on the behavioural reactions of species, but instead relies more on physical filtering of the catch (e.g. Catchpole *et al.*, 2006). The grid designs tested in *Nephrops* fisheries generally work by allowing those animals small enough to pass through a row of vertical bars to move into the codend, while those that are too large are guided to their escape (Figure 3). Consequently, large fish are expelled from the trawl, whereas the smallest fish can still be retained. Most of the recent work with grids has been done in the Swedish *Nephrops* fishery, during which a grid with bar spacing of 35 mm and a 70 mm diamond mesh codend significantly reduced the bycatch of fish when compared with a standard 70 mm diamond-mesh trawl. The grid trawl reduced the catch of full-sized fish (whiting, haddock and cod) by 80-100% and undersized fish by 30-65% (by weight) (Valentinsson and Ulmestrand 2008).

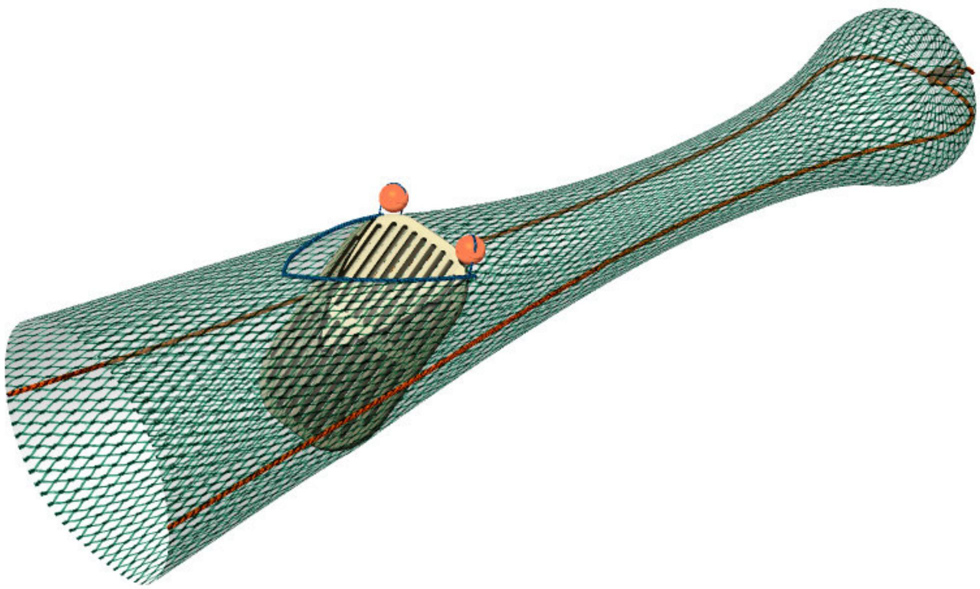


Figure 3. Nephrops trawl with grid (Copyright 2004 reproduced with permission of FRS, Aberdeen).

Trawls with the same basic specifications as those used in Sweden were also compared in the North Sea Farne Deeps fishery. The grid trawl significantly reduced marketable cod, haddock and whiting by 70-100% (by number). The number of undersized whiting was significantly reduced, but no change was detected for haddock, and the numbers of undersized cod increased by 114% (Catchpole *et al.,* 2006b).Criticisms of the grids by the industry include handling difficulties and blocking of the grid. Recent trials have investigated flexible grids, which are lighter and reduce handling difficulties by fitting more easily around net drums (Loaec *et al*., 2006).

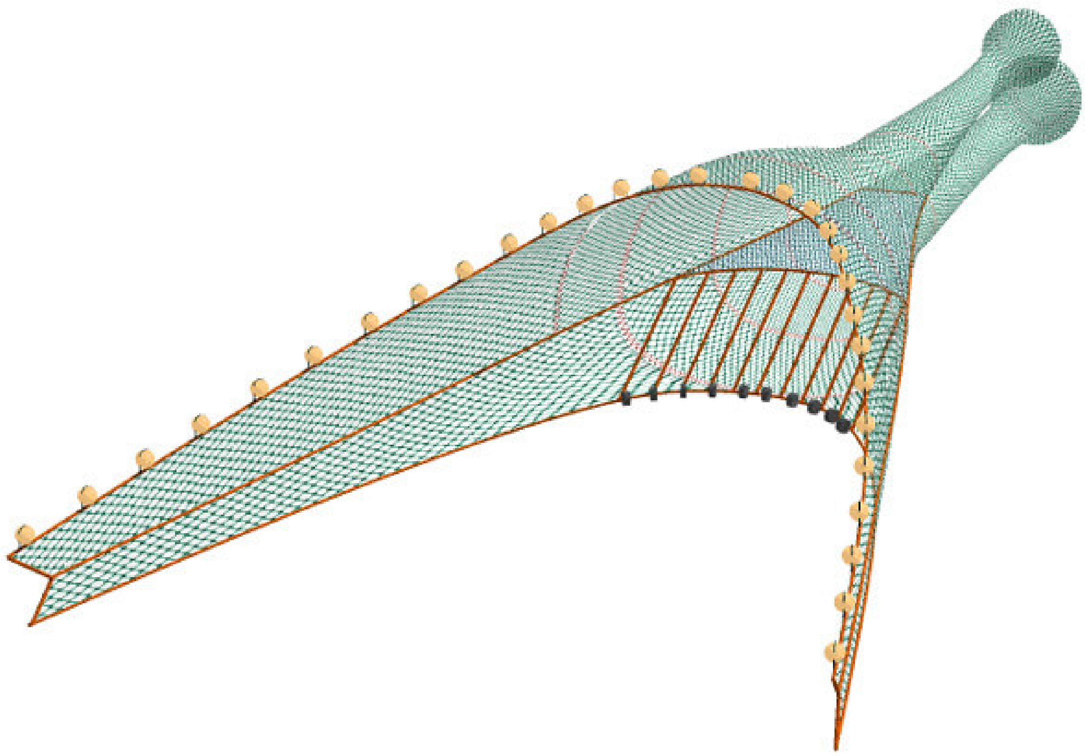


Figure 4 Horizontal separator trawl fitted with guiding ropes to encourage separation of cod from Nephrops (Copyright 2004 reproduced with permission of FRS, Aberdeen).

7.1.2. Separator and guiding panels

To utilize species behavioural reactions in trawls, separator panels have been inserted inside the net designed to separate whiting and haddock from *Nephrops* and groundfish. The separator panel is inserted at an appropriate height inside the trawl and terminates in two independent codends with different mesh size; a larger mesh size for the upper codend, retaining whiting and haddock, and a smaller mesh size for the lower codend, retaining *Nephrops* and other fish. Alternatively the upper codend may be left open thus releasing all fish that are sorted higher than the panel, in the case of guiding panels (Figure 4). As an alternative to the horizontal separator panel, Graham and Fryer (2006) inserted a grid into a two tier cod-end to retain the separation benefits of a grid while allowing for the retention of marketable fish in an upper cod-end constructed with a larger mesh size.

Guiding panels are generally shorter than separator panels, are situated at the end of the tapered section, and are set at an incline. The Inclined Separator Panel is one such design, and it was developed to facilitate the release of cod from *Nephrops* trawls in the Irish Sea (Figure 5). The separator panel is fitted into the trawl at an angle of 30o, starting 30 cm above the bottom sheet, to divert cod and other whitefish upwards towards an escape hole on the topsheet. Initial results demonstrated release rates of 68% for whiting, 98% for haddock and 68% for cod (Rihan and McDonnell 2003). Further trials have produced release rates of up to 91% for whiting and 77% for cod, but a significant loss of *Nephrops*, ~35%, has also been observed (BIM 2005a; BIM 2005b). Difficulties with this design include blocking of the escape panel with debris, such as seaweed, which can reduce the efficiency of the design and can lead to high losses of marketable catch.

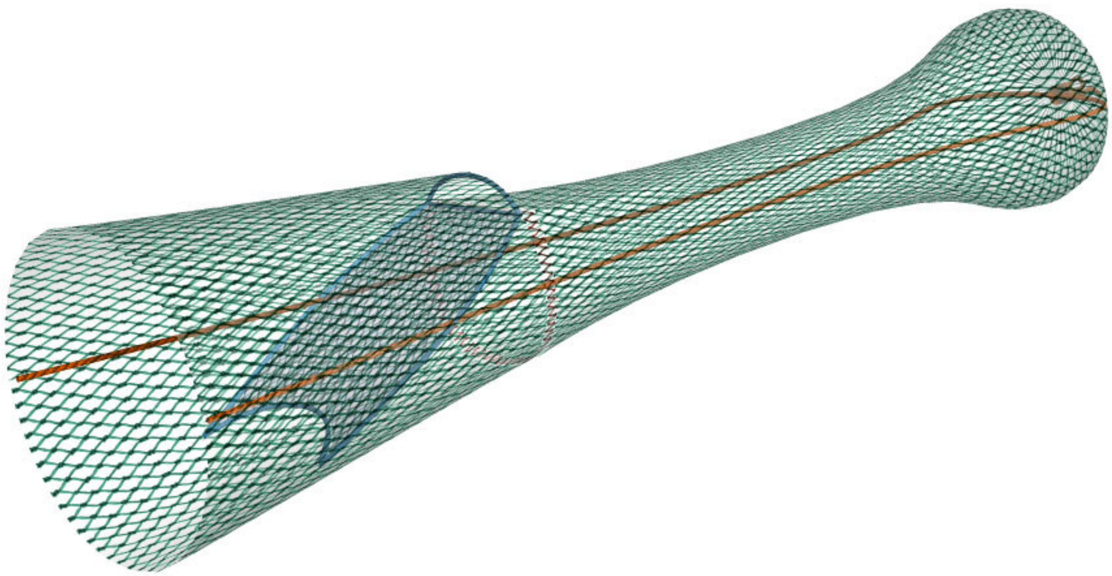


Figure 5. Inclined Separator Panel (Copyright 2004 reproduced with permission of FRS, Aberdeen).

7.1.3. Square-mesh panels

When conventional (diamond mesh) netting is rigged to hang with the bars parallel and perpendicular to the tow direction, the meshes adopt a square shape. Experiments have shown that these square meshes remain more open than conventional diamond meshes during trawling, so facilitating the escape of fish (Robertson and Stewart 1988). Moreover, the inclusion of a square mesh panel in the net (Figure 6) alters the physical conditions within the trawl in a way that encourages an escape response from several fish species. Observations indicate that fish respond actively to a sudden change in water flow and light conditions, as experienced by fish when they pass from diamond to square-mesh sections (Arkley 1990). There has been a myriad of experiments using SMPs (or windows) in *Nephrops* trawls. Panels of different size, mesh size and materials have been inserted in a variety of positions in the top of the trawl, principally to encourage the escape of whiting and haddock. Typically, insertion of a panel reduces the level of retention of whiting and haddock (Arkley 1990; Hillis *et al*., 1991; Thorsteinsson 1991; Ulmestrand and Larsson 1991; Madsen and Moth-Poulsen 1994; Robertson and Shanks 1994; Madsen et al. 1999), and the panels do not release *Nephrops* (Arkley 1990; FRS 2002).

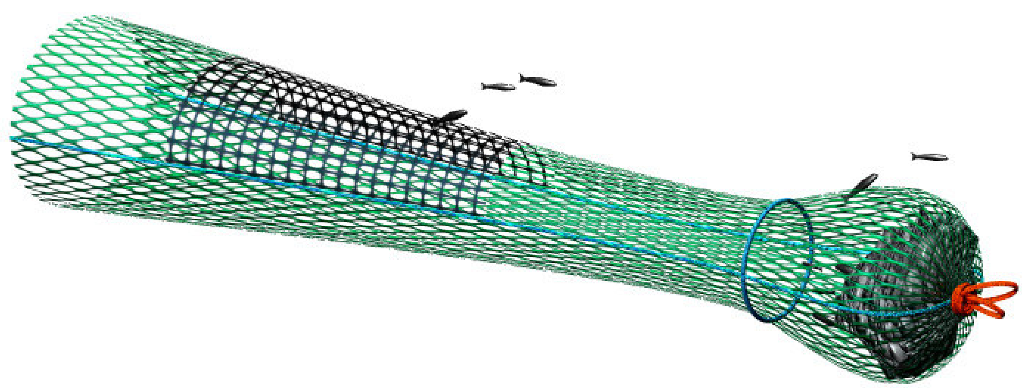


Figure 6 Square mesh panel inserted in a diamond mesh codend (Copyright 2004 reproduced with permission of FRS, Aberdeen).

7.1.4. Capture avoidance designs

The aim of such trawls is to avoid the initial capture of unwanted fish rather than improving their chances of escape from the trawl post capture. The principle is based on trawl designs previously used to target *Nephrops* in single-species fisheries. However, in the last 20 years, vessels have moved away from using these designs to using dual-purpose 'fish/prawn' trawls to capitalise on the marketable fraction of the fish bycatch. Prawn trawls have no sweeps and bridles, so no fish are herded towards the trawl, and a low headline (<2 m) with no cover (Graham and Ferro 2004), so even those whiting and haddock encountering the trawl escape over the headline. These are still used in some inshore fisheries as they enable access to areas in which it is not possible to manoeuvre larger trawls.

Trials with a contemporary prawn trawl or 'cutaway' design have been conducted in Mallaig, Farn Deeps and Clyde areas as well as the Celtic Sea (Figure 7). A conventional 'fish/prawn' trawl was altered by reducing the headline height, shortening the wing length, removing the cover, and increasing the mesh size in the upper panels of the net (FRS 2002; Revill et al. 2006). The trials demonstrated a considerable reduction in the numbers of haddock and whiting retained across the full size range, reduced cod catches by 11% (mostly in size range 15-30 cm) and increased *Nephrops* catches by 20% (Dunlin and Reese 2003). The cutaway trawl could reduce discarding of whiting in the Farn Deeps fishery by around 50%, but, only in proportion with the landings (Revill et al. 2006). The loss of marketable fish dissuaded fishers from adopting this design. Similar trials have been carried out in the Celtic Sea and unpublished data demonstrates that significantly reduces catches of whiting and hake can be achieved using this trawl design with no corresponding loss of *Nephrops*.

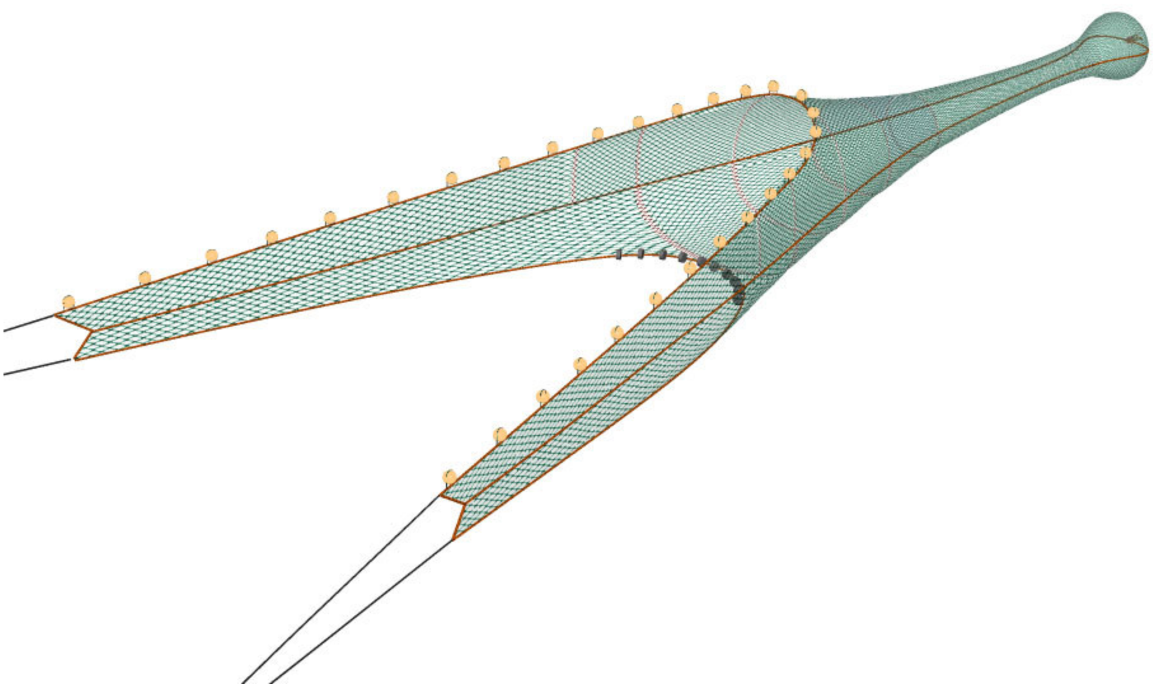


Figure 7. Cutaway trawl with set back headline (Copyright 2004 reproduced with permission of FRS, Aberdeen).

7.1.5. Cod-end modification

Some gear trials comparing different diamond-net mesh sizes have demonstrated that an increase in mesh size does not generally affect the selection range for *Nephrops*, but can reduce retention across the length range. Consequently, there is little difference in the catch composition, only in catch numbers. Robertson and Ferro (1993) showed that the *Nephrops* catch with the 80 mm mesh, the *Nephrops* catch was reduced by up to 34% but there was not difference in size selection between an 80mm and 70mm codend. Similar studies have demonstrated that there is the same selection properties for comparisons with 80mm and 70mm and 80mm and 90mm codends (Catchpole et al. 2005a; FRS 2002).

As with SMPs, the twine used in the codend influences the selection properties of trawls on *Nephrops*, whereby the use of thicker and more rigid twine or multiple twine reduces the selective properties of the codend (Polet and Redant 1994; Briggs et al. 1999). The results using square-mesh codends (Figure 8) are similar to those of increasing diamond-mesh size, i.e. the number of *Nephrops* caught is higher in the diamond-mesh codend than in the square-mesh codend (ICES, 2007). Comparing a 60 mm square-mesh codend with a 70 mm diamond-mesh codend, there is a loss in *Nephrops* of CL <45 mm.

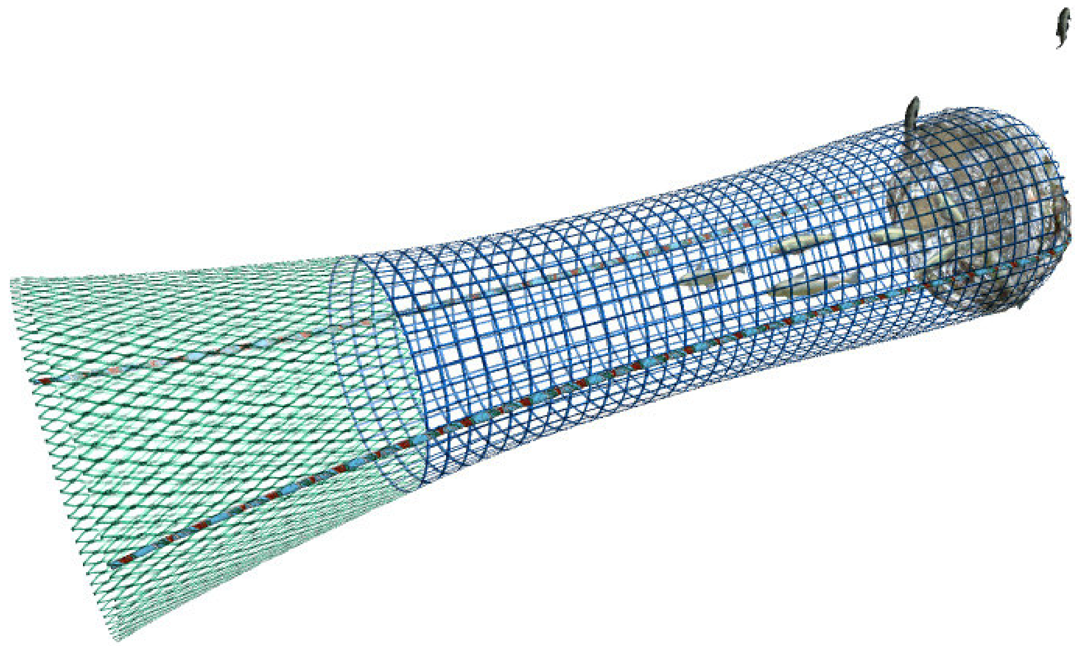


Figure 8. Full square mesh codend (Copyright 2004 reproduced with permission of FRS, Aberdeen).

7.2. Beam trawling in ICES divisions IV and VIId

There have been multiple studies conducted in the Belgian Beam Trawl fleet in relation to species selection. These studies, which are outlined below, have potential for reduction discards.

7.2.1. Benthos Release Panels

Several beam trawl adjustments investigating the effect of benthos escape modifications have been carried out. Fonteyne & 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. The average catch weigh reduction of benthos for the 200mm, 150mm, and 120mm square mesh windows was 83%,70% and 64% respectively, while the average reduction of debris for the same square mesh were 56%, 34%, and –7%.The results indicate that the size of the square mesh panel will determine the amount of benthic by-catch that can be released. While a 200mm square mesh window releases too much commercial catch (45% of sole numbers, 36% of plaice numbers) the study concludes that 150mm seems to be the best choice but a compromise must be made between the decrease of the benthos catch and the loss of commercial marketable fish.

Further investigations into square mesh panels (Revil & 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). Panel designs consisting of 150mm×5mmø double polyethylene square mesh or 150mm×6mmø single polyethylene square mesh reduced invertebrate bycatches by 75 and 80% respectively. Additional trials carried out by CEFAS in 2007 incorporated square mesh panels into a beam trawl in combination with a square mesh codend. Several combinations of the gears were tested with the most promising gear modification being a square mesh codend with two square mesh panels, both with 200mm mesh width, demonstrating reductions of bycatch fish and invertebrates of 60% and 40% respectively (Revill et al. 2007a).

7.2.2. Panel Alterations

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.

ILVO-Fisheries (Belgium) has also carried out research into alterations of the top panel of beam trawls, namely the use of cutaway covers and square mesh panels (Fonteyne 1997). Results from the trials found that the efficiency of the gears depended on the size of the vessel with smaller vessels and gears being the least efficient in allowing escape of fish. Roundfish such as whiting and haddock demonstrated a marked reduction in catches for the cutaway trawl, square mesh panel and cutaway and SMP combinations. This reflects the behaviour of these fish in the net, as they tend to stay in the middle or upper part of the net they are more likely to come into contact with the SMP or escape over the headline in the case of the cutaway trawl. Cod however, which tends to stay near the belly of the net did not escape from the trawls and as such the results were poor.

7.2.3. Cod-end Modifications

T-90 Codend

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 then 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. Trials carried out by the ILVO-Fisheries, Belgium (Depestele *et al*. 2008) show that the T90 cod-end 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.

Square Mesh Cod-end

As described earlier codend modifications have included square mesh codends (figure 9), which have been used in conjunction with square mesh panels with favourable results (table 9 from Revill *et al.* (2007a)

Figure 9 Square mesh cod-end being emptied on a beam trawler

Figure 10 Comparison of catches from a conventional beam trawl and one fitted with benthic release panels and a square mesh cod-end.

7.2.4. Combination Gears

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 (-3.65) of sole loss but conversely showed an increase in the amount of plaice (+6.4%). Revill *et al* (2007a) tested the combined effect of a benthos release panel in conjunction with a square mesh cod-end, Results form Revill *et al.,* (2007a) from both trials with a square mesh cod-end and the combined effect of a square mesh cod-end plus benthic escape panels are provided in table9 and figure 10. Even on its own, the square mesh cod-end reduces the overall level of discards significantly. The combined effect of the square mesh cod-end and benthic release panel is even more obvious, reducing overall discard rates in excess of 60%.;

S

A) ***Total fish and invertebrate discard numbers***
Standard trawl versus modified trawl (square-mesh codend only)

Vessel	Number of paired hauls	Standard trawl	Modified trawl (square-mesh codend)	Reduction in discards (%)	*p* value
		Total number of discarded fish			
Admiral Grenville	12	3 836	1 830	52%	0.00
Twilight III	12	2 158	1 505	30%	0.00
		Total volume (baskets) of invertebrates discarded			
Admiral Grenville	12	58	55	5%	0.21
Twilight III	12	28	25	11%	0.09

B) ***Total fish and invertebrate discard numbers***
Standard trawl versus modified trawl (square-mesh codend with square-mesh panels)

Vessel	No of paired hauls	Standard trawl	Modified trawl (square mesh cod end and square-mesh escape panels)	Reduction in discards (%)	P value
		Total number of discarded fish			
Admiral Grenville	7	1 653	618	63%	0.00
Twilight III	9	1 685	771	54%	0.00
		Total volume (baskets) of invertebrates discarded			
Admiral Grenville	6	38	22	42%	0.00
Twilight III	9	20	11	45%	0.00

Footnote: *p* is a statistical estimate of uncertainty associated with the results,

For example
p value of 0.00 indicates that there is essentially a zero probability that there is NO difference between the two gears
p value of 0.21 indicates that there is an estimated 21 % probability that there is NO difference between the two gears

Table 9 Reductions in discards (all organic material) obtained with a square mesh cod-end alone and combined with large square mesh release panels.

7.2.5. Spatial and temporal mitigation tools

There was insufficient time available during the meeting to fully explore spatial and temporal trends in all the available data. However, the sub-group reiterates the point of data paucity and given the low levels of sampling relative to total effort and the high degree of variability, it is likely that identifying any spatial and temporal trends will require considerable time and effort for model development and therefore not practically possible within the meeting timeframe. Analysis of discard data collected by a self-sampling programme in the Netherlands demonstrates both spatial and temporal trends in plaice discard rates associated with the beam trawl fishery and such information could be useful for defining particular areas and seasons that should be avoided.

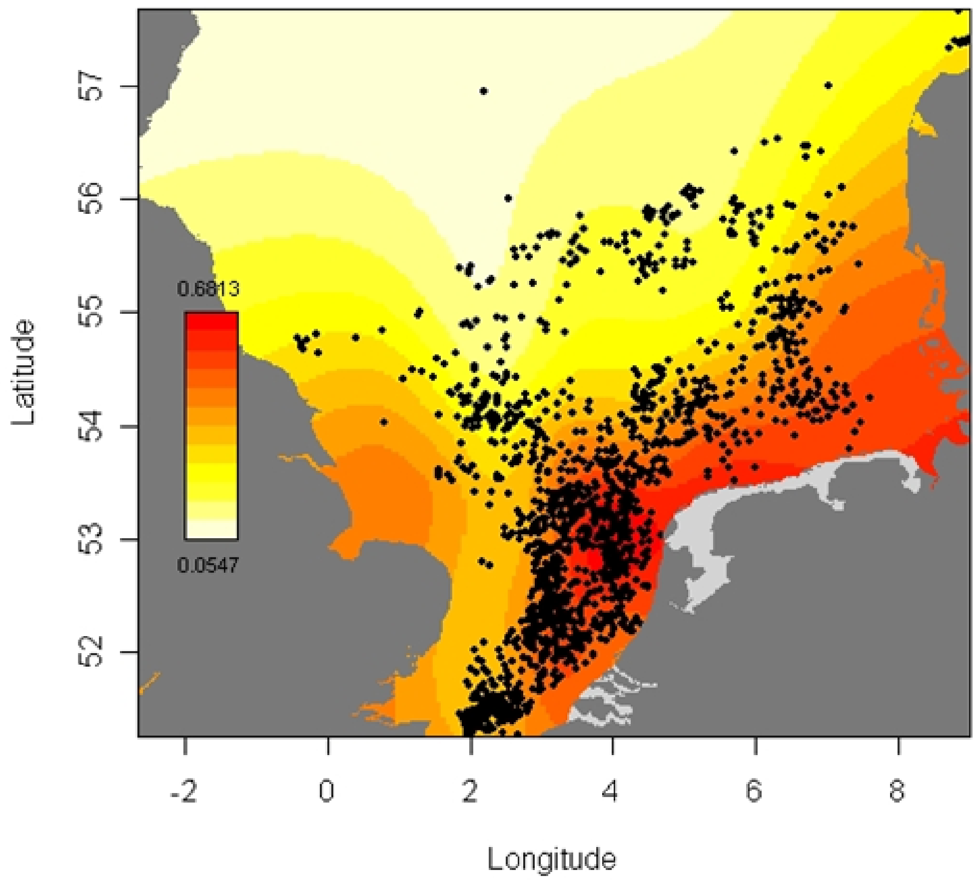


Figure 11 Model predictions of plaice discards (isodiscs) based on self-sampling data collected by The Netherland commercial sector. Positions of sampled trips are shown as black dots. Predictions are made for July with a beam trawler fitted with eight tickler chains.

The model shown in figure 11 demonstrates that for a given day (1st of July 2006 in this case) and a vessel with an average number of tickler chains (8 in this case), it is possible to plot how the discard fractions vary spatially. It is important to note that discard fractions not only vary spatially, but also change seasonally and vary with the number of tickler chains. Consequently, the absolute discard values in Fig 10 only apply to the arbitrarily chosen time (1st of July 2006) and vessel with 8 tickler chains. Nevertheless, the relative regional differences in discards captured by the model are the same under different conditions.

Figure 11 shows that discard fraction decreases away from the Dutch coast. Close to shore, in the northern part of the Netherlands, discard percentages can exceed (60%), while in the most northern regions of the North Sea, discard percentages are only a few percent. Another interesting feature is that further south, south-west of the province 'Zeeland', discard percentages are also lower (around 30 %), which is indeed also observed by fishermen. Spatial predictions along the UK coast and the coast of Denmark are based on almost no data points and thus very unreliable.

Similarly, the temporal changes in discard fractions can be plotted (Figure 12). Again, it is not possible to derive absolute trends in discards, but it can only be predicted for fixed values of the other variables in the model; spatial location (54° latitude, 4° longitude) and 'number of tickler chains from trawl head or shoes' = 8. Similarly to Fig. 6, the absolute discard fractions apply to these conditions only, but the relative trends in discard will be similar under different conditions (e.g. in different regions or for vessels with a different number of ticklers).

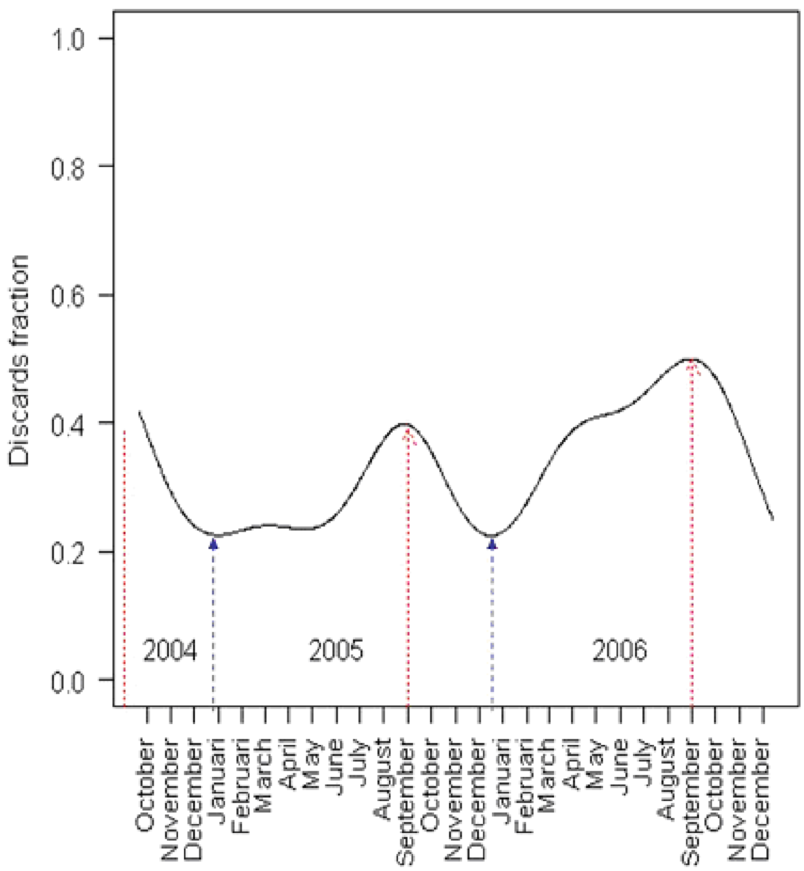


Figure 12 Temporal trends in discard rates associated with the Netherlands beam trawl fishery

One interesting feature is that there are clear seasonal peaks, with the highest discard levels in September in both 2005 and 2006 (and probably also 2004, see red arrows in Figure 12), and lowest discard levels in late December (see blue arrows in Figure 12). A similar analysis of the data presented to SGMOS-08-01 was conducted but due to paucity in the data and high variability it was not possible to distinguish any obvious seasonal patterns. As more data becomes available, it is suggested that these are analysed for potential seasonal trends.

8. ECONOMIC STATUS OF FISHERIES

Economic background of the fleets

Beam Trawler

In Beam trawl fleet of Belgium, the Netherlands, Germany and the UK are quite unprofitable over years because of increasing fuel costs. In the last Annual Economic Report with data from 2006 it is already stated that the fleet of the Netherlands face average losses per vessel which are quite considerable. A new decommissioning program was introduced in the Netherlands in 2006 and lead to a decrease of the fleet by 24 in 2008. More will follow. Additionally, lower quotas for flatfish and decreasing fish prices add to the problems to make a profit. In Belgium the average loss per vessel in 2006 was 180,000 € in the segment DTS 2440. For the Netherlands the annual loss for the segment Beam trawler over 40 m mounted to around 790,000 €. There are actual reports that the fishing companies loose their crew due to decreasing crew shares. Crew share is normally a certain proportion of the catch value reduced by a proportion of the running costs. Increasing fuel costs are divided between owner and crew normally by 50% each. Therefore, increasing fuel costs lead to a lower crew share especially if fish prices stay more or less at the same level.

Nephrops fisheries

The fleet segments with nephrops as a main target species are normally multi-species fishing operations targeting also whitefish species. Only few vessels are targeting nephrops as a single species. In area VII mainly vessels from Ireland, France and the UK participate in the nephrops fishery. The fishing vessels using a wide variety of fishing gear including both single and twin rig trawls. In 2006 some fleet segments were profitable. Because of increasing prices for nephrops (increase of 94% between 2003 and 2006) some vessels targeting now nephrops instead of whitefish. This is also due to decreasing catch possibilities for whitefish. However, in nearly all fleet segments targeting nephrops as a main species bycatch of whitefish species build a significant proportion of the value of landings. The average profit of a vessel in the segment ‘demersal and seine 24-40m’ in the UK was 69,700 € in 2006. In Ireland the small scale inshore fleet < 12 m reduced their loss from around 6,100 € to 290 € in 2006. For the segment 'demersal trawl and seine 12-24m' the average loss mounted to 31,800 €. Increasing fuel costs also the fleet segments targeting nephrops face a severe crisis and it is hard to realise a profit.

9. PREDICTING THE IMPACTS OF MITIGATION TOOLS

9.1. General Comments

The sub-groups ability to predict the effects of the various measures available must be treated as indicative as these predictions are based on a number of assumptions.

A range of possible measures to reduce discards are available. It is assumed that these are achieved through reducing the retention of unwanted fish in the gear, rather than simply landing discards, are available. The measures included both technical modifications to the fishing gear and to a lesser extent, spatial and temporal changes to reduce discards. As a mitigation tool, the latter approach was only considered for the beam trawl fishery, due to lack of available information and the discrete spatial definition of *Nephrops* fisheries due to the strong association with habitat type. Modelling the technical and economic consequences of shifts in spatial and temporal changes in fleet activity are by default difficult to estimate due to data paucity and in predicting what the likely impact on target and non-target species may be.

It should be noted that in several cases, the results from gear trials conducted in other areas have been applied and extrapolated to both the IV/VIId beam and VII *Nephrops* trawl; fisheries. These data form the basis of the sub-groups attempts to ascertain whether it is technically feasible whether the reduction targets outlined in the Commission non-paper can actually be achieved. While this may provide an approximate estimate of the likely effects, it is on the assumption that the modifications result in similar outcomes when extrapolated between fisheries. Experience has shown that this may not be the case. Localised differences in population structure, seasonal effects and other fishery specific differences are known to influence the effectiveness of particular measures.

9.2. Area IV and VIId Beam trawl fishery

9.2.1. Spatial and Temporal Changes in Fishing Activity

Analysis of discard data collected through an industry self-sampling programme demonstrates that discard rates associated with the beam trawl fishery are lower further offshore and in areas more northerly of present activity. However, based on industry comments and the expert judgement of the sub-group, it is considered that any spatial shift to reduce discards would result in reduced fishing opportunities for sole and will increase operating costs further due to the additional fuel needed to cover the increased steaming time. Given the current costs associated with fuel, the negative profitability - this option, together with reduced fishing opportunities presents a significant disincentive to adopt temporal adaptations to reduce discards, as it is unlikely to present an economically viable option to the beam trawl segment.

9.2.2. Technical Modifications

In general terms, the aggregated level of discarding across all species is high (89% by number and 55% by weight). Discard levels for plaice (indicator species) and cod (recovery species) also have high rates of discards (by number), 74 and 76% respectively. The sub-group concluded that with the exception of mesh size alterations, there are no other mechanisms available to provide significant reductions in the discard rates of plaice. The sub-group simulated (in the absence of selectivity data on larger mesh sizes) the effect of mesh size increases on the retention of plaice and sole. Selectivity data for an 80mm cod-end from Depestele *et al* (2008) was used to estimate the selectivity parameters of a 90 and 100mm cod-ends. This assumes a constant selection factor (50% retention length/mesh size) across mesh sizes.

The sub-group note that these parameters should be revised in light of any new selectivity data becoming available and the results presented here are only indicative of the likely reductions in discards and marketable fish.

Increasing the mesh size to 90 or 100mm is predicted to reduce plaice discards by 10 and 24% respectively, but this would also equate to losses in marketable sole of 14 and 32% respectively. Therefore, increasing mesh size as a unitary measure to reduce plaice discards inline with the targets is unlikely to be met without using a mesh size well in excess of 100mm. Such an increase in mesh size would drastically reduce the retention of commercial sole. While the desired reductions in plaice are not considered technically or economically feasible without having major impacts on the capture of sole, there are a number of other technical modifications available, which in combination could potentially be used to reduce the overall (all species) discard rate. Revill et al (2007a) tested two gear modifications separately and in combination aimed at reducing discards associated with the SW England beam trawl fishery. A full square mesh cod-end coupled with a large square mesh ‘drop out panel’ reduced the unwanted fish by-catch by up to 60%, although the authors do not describe the effect by species, it is clear that such a modification would make a significant contribution to reducing discards overall. However, such a modification is likely to have no impact in reducing the discard rates of plaice. Fonteyne and M’Rabat (1992) and Millar and Walsh (1992) both conclude that the use of square mesh cod-ends are less selective for flatfish compared to conventional diamond mesh as diamond mesh are more suited to the body form of flatfishes. Therefore, while potentially minimising the loss of sole, this modification is likely to offer no substantial reduction in plaice discards.

Van Marlen (2003) demonstrates that it is possible to release a substantial percentage (30–40%) of roundfish species (whiting and cod) from a beam trawl with minimal influence on the flatfish catches (sole, plaice) using very large (2m+) meshes in the upper part of the beam trawl. Depestele (2008) note that roundfish species like haddock and whiting, which stay in the middle or upper part of a trawl when they are caught can escape through escape openings in the top panel of a beam trawl constructed from square mesh. However, the efficiency depends on the size of the escape opening and consequently they are only efficient when inserted in the larger beam trawls. Cod, however, a species remaining close to the belly of the trawl when caught, takes no or little advantage of these escape openings.

It should be noted that significant reductions in the by-catches of benthos have also been demonstrated in the beam trawl fishery through the use of square mesh panels fitted in the belly of the trawls. While benthos is not considered within the discards/by-catch criteria used here, their effect is significant and should also be promoted, not least through potential improvements in catch quality which could partially offset some of economic losses associated with the measures identified above.

In summary, it is likely that the combined effect of these measures could potentially achieve the desired initial reductions (40%) although these may induce some level of commercial losses. The sub-group therefore conclude that while these reductions are technically feasible, the economic analysis shown in section 10 suggests that that even without any associated reductions in target species (particularly sole) the economic viability of the fleet is currently unsustainable and all fleet segments are currently generating significant losses. The sub-group note that it is likely that any measure required to meet the specified target reductions, particularly those required to reduce discard rates of plaice, would make the economic situation even worse and can not identify any technical or spatial/temporal solutions that would not impact on current fishing opportunities while achieving the desired reductions in discards.

9.3. Area VII *Nephrops*

Simulations based on applying selectivity data obtained from commercial selectivity trials have been applied in two ways. The first considerers selectivity data obtained from a number of trials conducted in the North Sea aimed at reducing discard levels in the area IV *Nephrops* fishery using square mesh panels of differing mesh size and position, both factors are know to influence the effectiveness of panels, Selectivity profiles for each gear are presented for cod, haddock, *Nephrops*, whiting and hake. For illustrative purposes, haddock selectivity data from a standard 80mm trawl and one fitted with a 110mm square mesh panel are applied to two haddock populations to compare the effect between gears and population structure on overall discard rates.

The second simulation uses selectivity data from a range of technical measures that have been tested in both the North and Irish Seas. There effectiveness at reducing whiting discards are presented by applying the selectivity data to the length frequency data (landings and discards) obtained for the purposes of the sub-group meeting. The effectiveness of each gear type in reducing discards and their utility in achieving whiting reductions in line with the overall targets are presented.

9.3.1. *Effectiveness of Square Mesh Panels tested in the area VI Nephrops fishery*

The Marine laboratory, Aberdeen have conducted four sets of trials in the North Sea in the past 3 years to measure the selectivity of roundfish and *Nephrops* in *Nephrops* gears. A range of square mesh panels with different mesh size and position have been tested in codends of either 80 or 95mm (Table 10). Two vessels have been used: Solstice and Zenith. Summary graphs are presented which show the comparative proportional reductions in catches at length for a number of species (cod, haddock, whiting, hake and *Nephrops*). The selectivity data presented here is not used to predict the effect on discard rates associated with the catch data from area VII, but to demonstrate the potential impact of each of the gears tested for illustrative purposes.

The gears used in the trials on Solstice and Zenith had the specifications indicated in the table and have been identified using the codes in the right hand column which are:

vessel letter codend mesh - SMP mesh - smp position - E or T

where E or T indicates whether the SMP is in the straight Extension or Taper.

Vessel	Codend mesh mm	Codend twine mm	Open meshes	Lifting bag	SMP mesh mm	SMP position from codline	Taper or straight Extn	Code * indicates that data for day & night available
S06	95	5D	100	Y	120	13-18	E	S95-120-13-18E
	80	5D	120	Y	80	15-18	E	S80-80-15-18E
	95	5D	100	Y	120	4-9	E	S95-120-4-9E
S07	95	5D	100	Y	120	4-9	E	S95-120-4-9E*
	95	5D	100	Y	120	9-14	E	S95-120-9-14E
Z07	80	4S	120	Y	120	13-18	E	Z80-120-13-18E*
	95	5D	100	Y	120	9-14	E	Z95-120-9-14E*
Z08	80	4S	120	Y	120	15-18	T	Z80-120-15-18T
	80	4S	120	Y	110	15-18	T	Z80-110-15-18T
	80	4S	120	Y	110	15-18	E	Z80-110-15-18E
	80	4S	120	Y	-			Z80-0-0-0

Table 10 Technical specifications of the gear modifications tested

Detailed drawings of the codends and panels used on trials S06 and S07 can be found in Kynoch et al. (2007). Trial S06 measured the selectivity of a 95mm codend with a 120mm panel at two extreme positions 13-18m and 4-9m from the codline. An 80mm codend made of 5mm double twine and 80mm panel complying with the current EU regulations in the North Sea was also tested for comparison.

Trial S07 repeated the test of a 95mm codend with the panel at 4-9m and also tested an intermediate position at 9-14m.

Trial Z07 concentrated on getting data during the day and night for the intermediate panel position (9-14m) with the 95mm codend and for an 80mm codend with 120mm panel proposed by industry.

Finally in 2008 110 and 120mm panels were tried at the back end of the taper of the net and compared with a 110mm panel at the same distance but in the straight section. An 80mm codend with no panel was also tested.

The data were analysed using smoothers (Kynoch et al., 2007). The relative catch rates at length are presented in figures 13 to 21 for a range of species. Relative catch rate is effectively the proportion retained by the experimental cod-end of the population entering the gear, assuming that the twin trawl split is 50:50. Information on most gears is available for cod, haddock, whiting and *Nephrops*. There is also some limited but interesting data for hake from trip Z08.

Summary graphs (figs 13-19) for each roundfish species are presented, divided into two cases: 95mm codends and 80mm codends. Data for the same gear (95-120-4-9) used on 2 trips on Solstice have been combined since they are not different. The same gear (95-120-9-14) on Solstice and Zenith however, does show a significant difference and are shown separately. Day and night cases for cod and whiting have been combined as differences are not significant or only marginally so. There is a difference between day and night for haddock so only the day cases have been used here. Other factors such as weather were tested for but not found significant.

In addition to the full lines representing the smoothers, there is also a dotted line on the graphs for cod, haddock and whiting showing the predicted proportion retained for the codend alone (either 80mm or 95mm as appropriate) (Anon, 2003). The difference between the dotted line and any individual smoother gives an estimate of the effect of the experimental square mesh panel on retention.

In general the *Nephrops* results (figures 20 and 21) do not provide evidence that prawns pass through the panels since the smoothers are mostly not significantly *different* from 1. In some cases where there is a significant difference it may be explained by size selection by the 80 or 95mm codend. It is noticeable that the gear showing the most obvious length-related selection is the 80mm codend made of 4mm single twine. All other codends, whether 80mm or 95mm are made of 5mm double twine.

The models presented clearly demonstrate that significant reductions in the retention of fish can be achieved thought the use of square mesh panels of mesh sizes similar to those used in demersal fish fisheries (120mm). Their effect is most pronounced on haddock and whiting, and to a lesser extent for cod and hake.

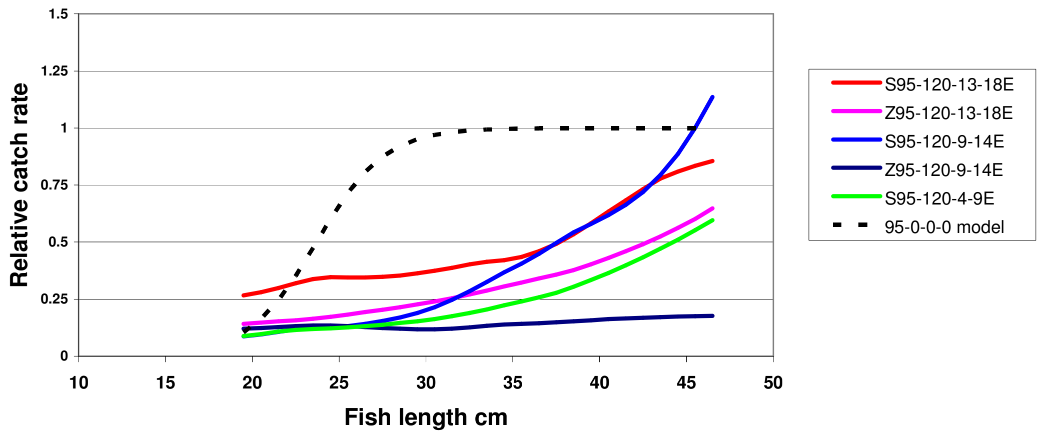


Figure 13.Haddock selectivity of a 120mm, 5m long square mesh panel inserted in different positions and contrasted with a 95mm cod-end with no panel (dashed line)

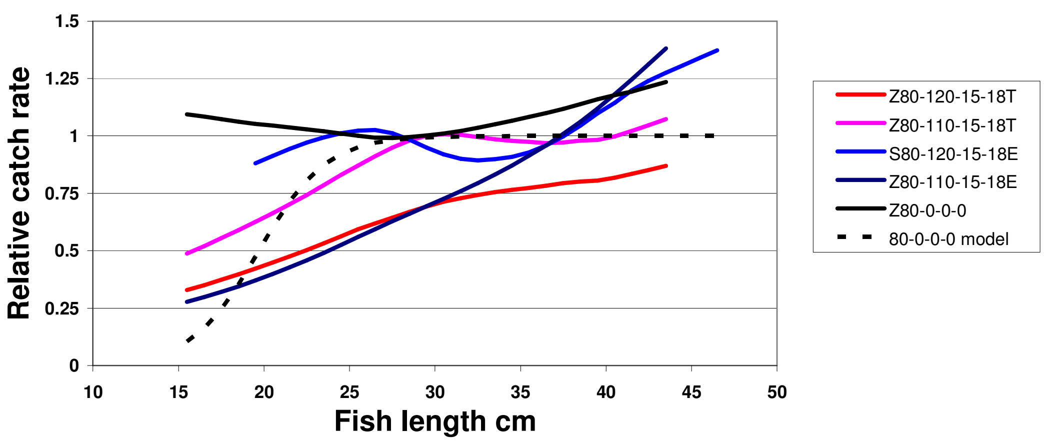


Figure 14 Haddock selectivity with a 110 or 120mm, 3m long square mesh panel inserted in the taper or extension of the trawl.

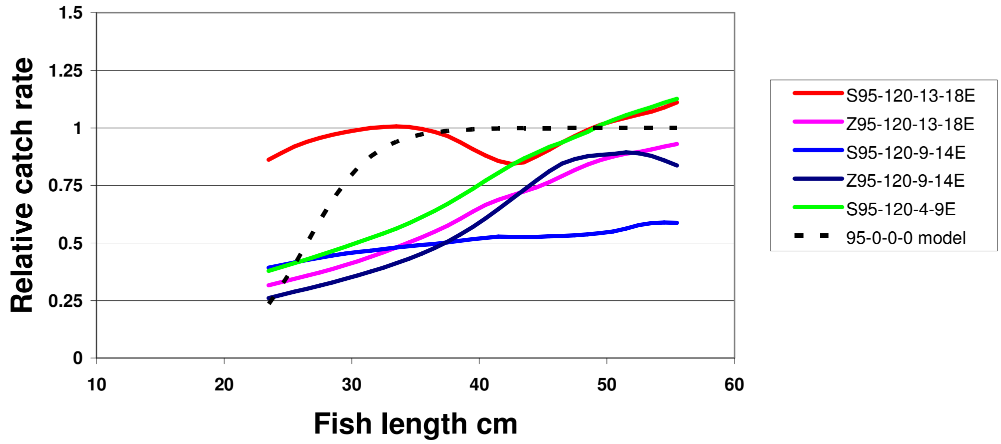


Figure 15 Cod selectivity with a 120mm, 5m long square mesh panel inserted in various positions of the extension.

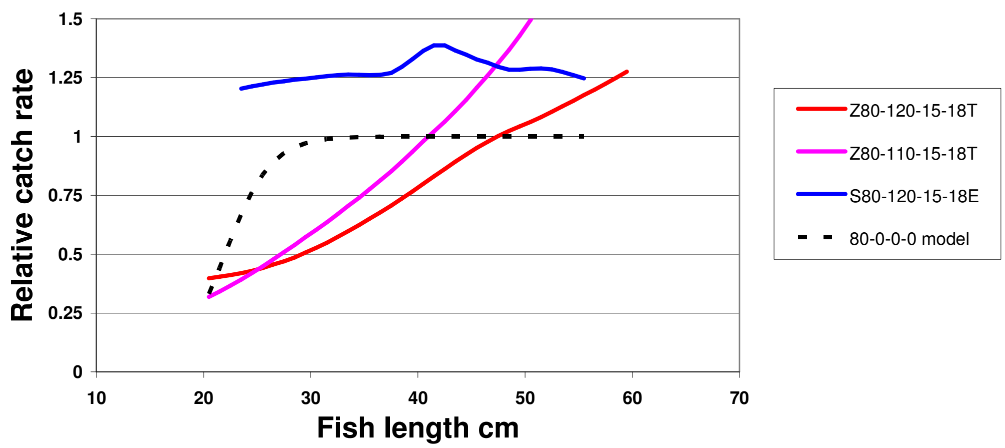


Figure 16. Cod selectivity with a 110 or 120mm, 3m long square mesh panel inserted in the taper or extension of the trawl.

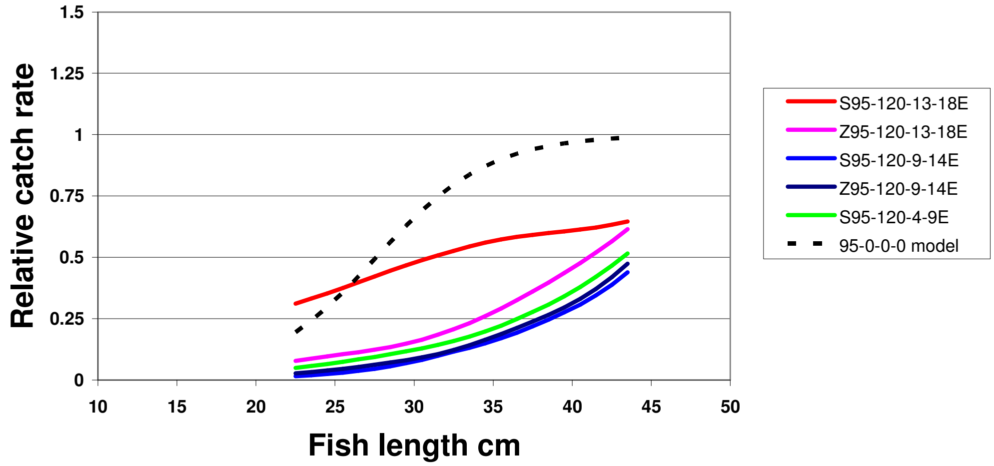


Figure 17. Whiting selectivity with a 120mm, 5m long square mesh panel inserted in various positions of the extension.

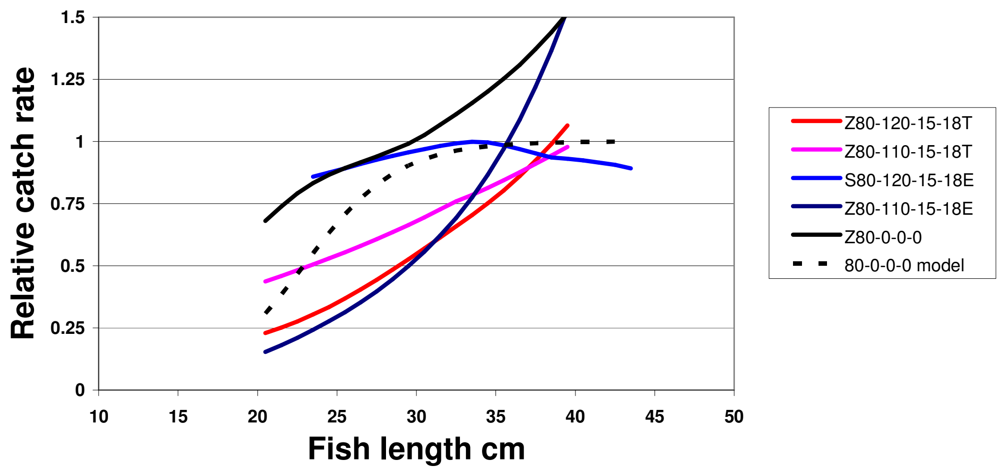


Figure 18.Whitng selectivity with a 110 or 120mm, 3m long square mesh panel inserted in the taper or extension of the trawl.

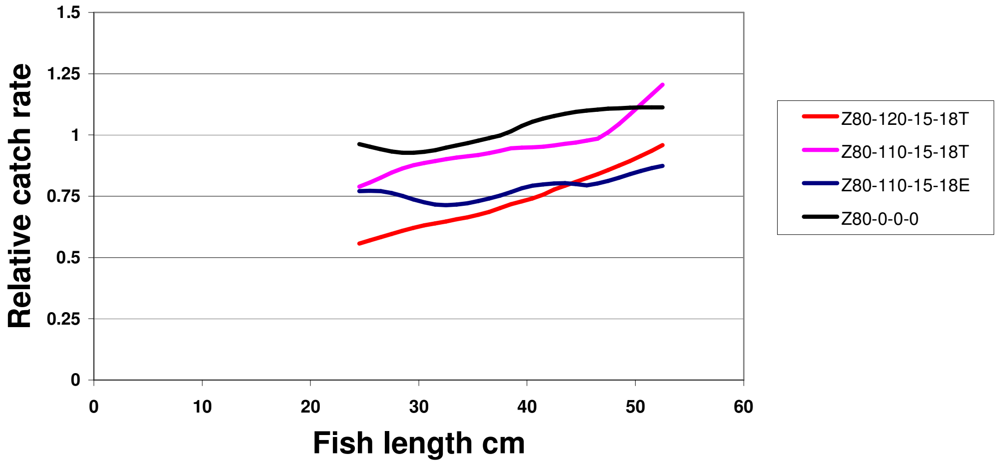
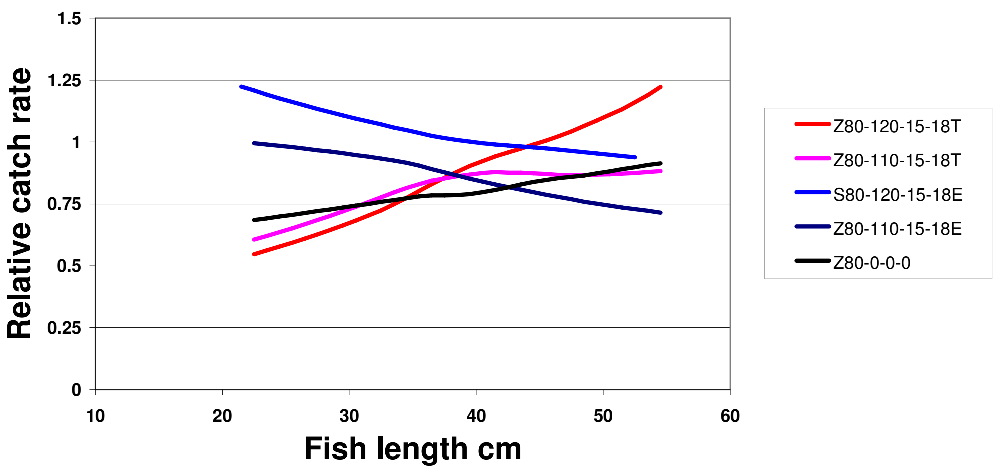


Figure 19 Hake selectivity with a 110 or 120mm, 3m long square mesh panel inserted in the taper or extension of the trawl.



8.

Figure 20. Nephrops selectivity with a 110 or 120mm, 3m long square mesh panel inserted in the taper or extension of the trawl.

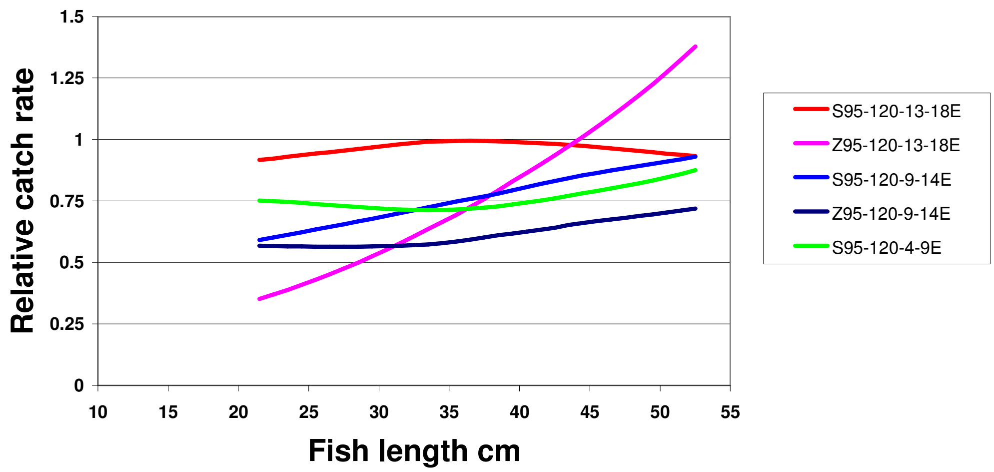


Figure 21. Nephrops selectivity with a 120mm, 5m long square mesh panel inserted in various positions of the extension.

To illustrate the effect of one of the gear modifications and the impact that this can have on retention of fish, two scenarios are presented. These not only illustrate the effect of gear modifications but also the influence that population structure can have on discard rates. Using the selectivity data for a standard 80mm (Z80-0-0-0) cod-end and a trawl fitted with a 110mm square mesh panel (Z80-110-15-18E) and two different haddock populations, one comprising of largely small fish and one with a broader length spectrum, it is possible to describe the discard rates for each gear and to compare the relative reductions in catches between the two gears. Figures 22 and 23 show the overall population entering the gear (Popn) and the associated retained catch for each of the modifications.

It can be seen that few fish below 18cm are retained in either case, but for the 'standard' cod-end all fish above 20cm are fully retained. In contrast in both cases, the model predicts that with the inclusion of a square mesh panel, the retention of fish, particularly those below 25cm is reduced dramatically. In the first scenario, with the 'small' population, catches of haddock below and above minimum landing size are reduced by 58 and 21% respectively. Under the second scenario, with the wider population structure, the results contrasting the two gears are broadly similar, with reductions of 45 and 16% in catches below and above MLS respectively. However, what is interesting to note, that despite the significant reductions between the two gears, the effect on discard rates are less marked. In the first case presented, as the population comprises mainly of fish below MLS with few large fish in the population, discard rates will inevitably be high. Rates (by number) associated with the 'standard' gear are estimated to be 97% and despite the large reductions in catches between the two gears, the discard rate only falls to 93% with the more selective gear, clearly illustrating that even with more selective gears, discard rates can be high when fished on populations which comprise mainly of small fish. Under the second scenario presented, the discard rates are estimated to be 53 and 43% respectively for the standard and more selective gears.

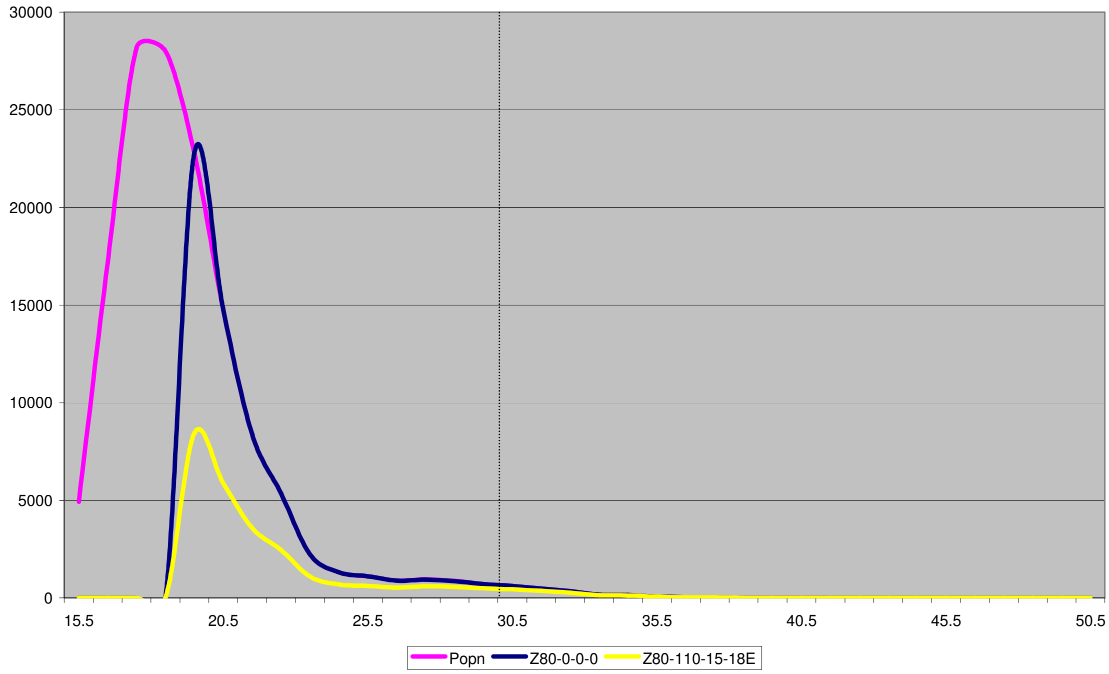


Figure 22 Comparison between a standard and more selective gear when fished on a haddock population comprising mainly of small fish. The vertical line is the MLS.

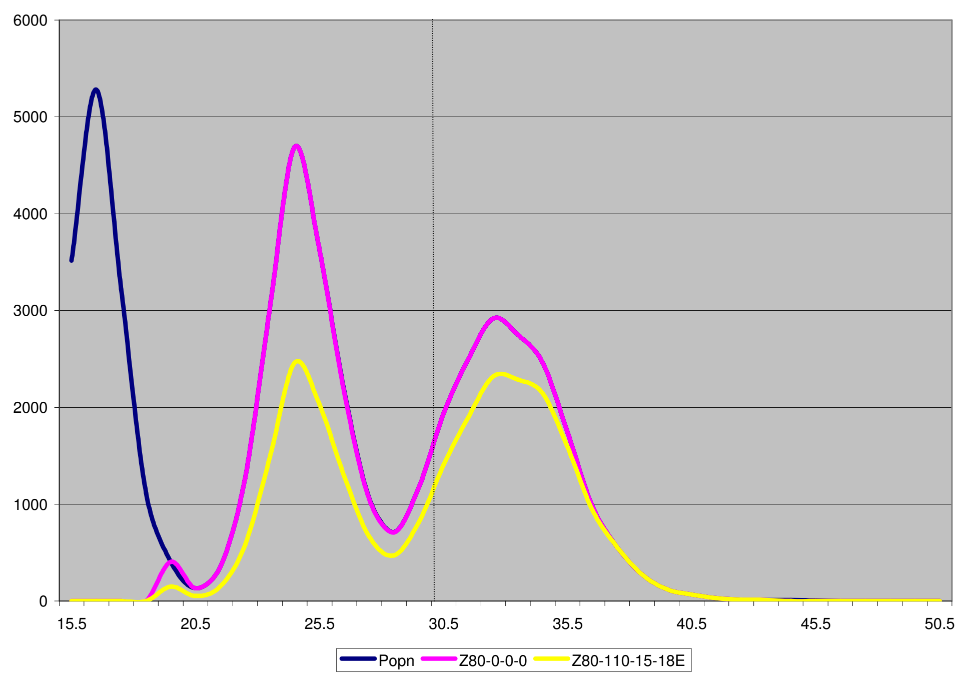


Figure 23 Comparison between a standard and more selective gear when fished on a haddock population with a broad length spectrum. The vertical line is the MLS.

9.3.2. *Simulations on the impact of selective gears using length data submitted to SGMOS 08-01*

Further to a review of relevant research into gear modifications to improve selectivity, an analysis of catch comparison data from selective gear trials was conducted to quantify the technical feasibility of discard reduction in the *Nephrops* trawl fishery in ICES Sub Area VII. The results from tests of selective *Nephrops* trawls were applied to the catch patterns observed in trips sampled by scientific observers on board *Nephrops* trawlers in ICES Sub Area VII. Data from trials of ten selective trawl designs were analysed to quantify the potential reduction in discards and discard rates that might be expected if the *Nephrops* trawl fleet were to adopt these modifications (Table 11).

A model was fitted to the catch comparison data, which was then applied to the observed catch data. For each haul and species, the proportions of each length class caught in a control trawl (conventionally used in the fishery) relative to the total number caught by both the control and an experimental trawl (the split parameter) were analysed using a Generalised Linear Mixed Model (glmm) with multivariate normal random effects, using Penalised Quasi-Likelihood (glmmPQL). Rene Holst, Difres, developed this method as part of the EU study, NECESSITY. The model fits are presented in Figures 25 - ??. A proportion of one indicates that all the fish of that length were caught in the control trawl and none were caught when using the experimental trawl. A value of 0.5 indicates that the experimental trawl did not affect that numbers of fish caught at that length. The analyses accounted for variation between hauls to generate a significantly fitting model and its limits of significance.

All French and UK data were combined to generate catch length frequencies for WHG, HAD and HKE, and the proportions discarded at each length class from all sampled trips in all years (2005-07). Irish sample data were not included because numbers of fish at length were available for only the discard fraction and not the landed fraction. The species selected were those that constitute most of the discard fraction (based on the sampled trips) and for which data were sufficient to generate a model with a significant fit. The catch comparison model parameters were applied to the catch length frequencies to generate revised catch at length estimates to predict the change in catch pattern that would have occurred had each experimental gear been used during the sampled trips. The proportions discarded at length were calculated for these revised catch numbers assuming the proportion of discards at length was the same as in the sampled trips. The total numbers discarded and landed and the estimated discard rate by number for each species had the experimental gears been used were calculated. The range around these values was calculated based on the confidence levels of the model fit. The estimated reduction in overall contribution to discards of all fish species were also calculated (Table 11).

The results illustrate the potential for substantial reductions in discards through the use of gear modifications to *Nephrops* trawls (Table 11). For example, the grid and square mesh codend combination design would have reduced discards of whiting by an estimated 97% had this gear been used during the sampled trips. This would have equated to a discard rate for whiting of 26%

compared to the currently estimated rate of 84% (Figure XX). Associated with this reduction in discards, however, would have been a reduction in landings of whiting of 33%, with a range of 14-52% by number. Using the grid in isolation showed little reduction in discards because many of the small whiting that dominated the sampled catches are able to pass through the grid and would be retained in the codend. The various other modifications showed good potential to reduce discards of whiting numbers by 36-86%. The estimated changes in the rate of discarding of these new designs were 54-99%. The reductions in discard rates from the models were less pronounced than changes to number of discards because the modifications released both fish that would be landed as well as discarded. The change in whiting landings estimated from the using the gear modifications was highly variable from an increase in landings of 25% to a reduction of 94%.

During sampled trips, the number of whiting discards accounted for an estimated 18% of all fish discarded. The estimated reduction in the percentage contribution of the discards of whiting attained through the use of these gear modifications varied between 0 and 18%, i.e. total discard numbers of fish could be reduced by up to 18% through the changes to whiting catches. In general the greater the reduction in whiting discards the greater that reduction in landed whiting.

Data were also available for an analysis of the possible effects to haddock and hake catches. In accordance with the results for whiting the results suggest that a number of trawl modifications could potentially reduce discard rates and numbers, and as with whiting the range associated with potential changes to discard and landings was considerable. Haddock and hake combined constitute around 7% of all discards by number; the analysis suggests that this value could be reduced to around 3-4%.

The different catch comparison trials from which data were utilised were generally conducted in one specific area and the model generated from some trials was based on only ten comparative tows made on one vessel. Moreover, not all the gear trials were conducted within ICES Sub Area VII; some were conducted in the North Sea *Nephrops* fishery (Sub Area IV). Therefore, the results presented assume that the performance of the trawls towards the fish population encountered during the trials was comparable between areas and between *Nephrops* trawl fishery métiers in Sub Area VII. It has been shown that during trials of the designs selected here that their performance can be variable between areas. Furthermore, the models generated are based on the length range of fish encountered in the trials but an extrapolation was applied to the widen length range to that of the observed population in the sampled trips.

The sampled trips in the French and UK *Nephrops* trawl fishery identified 160 fish species that were caught and discarded. Whiting, hake and haddock make up 25% of the estimated number of fish discarded from these sampled trips. This analysis has enabled the potential for trawl modifications to reduce discarding in the *Nephrops* fishery in ICES Sub Area VII of these species to be quantified. The results presented demonstrate the potential to reduce discards of these species but the effect on the other species could not be quantified. However, it can be inferred from scientific publications that the unwanted catches of other species can be reduced with the trawl modifications analysed here. The range in potential outcomes, both in terms of discard reduction numbers/rates and in the effect on landings is wide, however, when taken in conjunction with information from the scientific literature it is apparent that substantial reductions in discarded fish species is possible through modifications to the design of *Nephrops* trawls.

Table 11. Gear modifications and details of trials.

Trawl modification	Description of main features	Trial location	Hauls	Reference
Grid with square-mesh codend	Swedish grid, with bar spacing 35 mm combined with 70 mm square-mesh codend	Farn Deeps (IV)	10	(Catchpole et al., 2006)
Selection grid	Swedish grid, with bar spacing 35 mm	Farn Deeps (IV)	10	(Catchpole et al., 2006)
Dyneema panel	One square-mesh panel (95 mm mesh) constructed of high strength knotless thin twine at 12-15 m from codline	Farn Deeps (IV)	10	(Revill et al., 2007b)
Double square-mesh panel	Two PPE square-mesh panels (~85 mm mesh) at 12-15m and 20–23 m from codline	Farn Deeps (IV)	10	(Revill et al., 2007b)
100 mm diamond codend	100 mm diamond-mesh codend	Farn Deeps (IV)	10	2005 (unpubl.) Seafish
Large mesh panel	Large diamond mesh panel 160 mm in the topsheet	Irish Sea	197	(unpubl.) ANIFPO
Inclined separator panel I	Panel set in the aft section of the trawl at an incline leading to escape hole	Aran Grounds (VIIb)	17	2001 (unpubl.) BIM
Inclined separator panel II	Panel set in the aft section of the trawl at an incline leading to escape hole	Smalls(VIIg)	2x20	(Necessity, 2007) BIM
Large mesh wings	Wingends and top sheet in 160 mm mesh-size	Aran Grounds (VIIb)	23	2001(unpubl.) BIM
Coverless trawl	Headline lowered and set back	Smalls (VIIg)	17	(Necessity,

Figure 24 Discarded and landed length frequencies (pooled) of most commonly caught fish species from French and UK sampled trips 2005-07 on Nephrops trawlers in ICES Sub Area VII (solid line = discards, dotted line = landings).

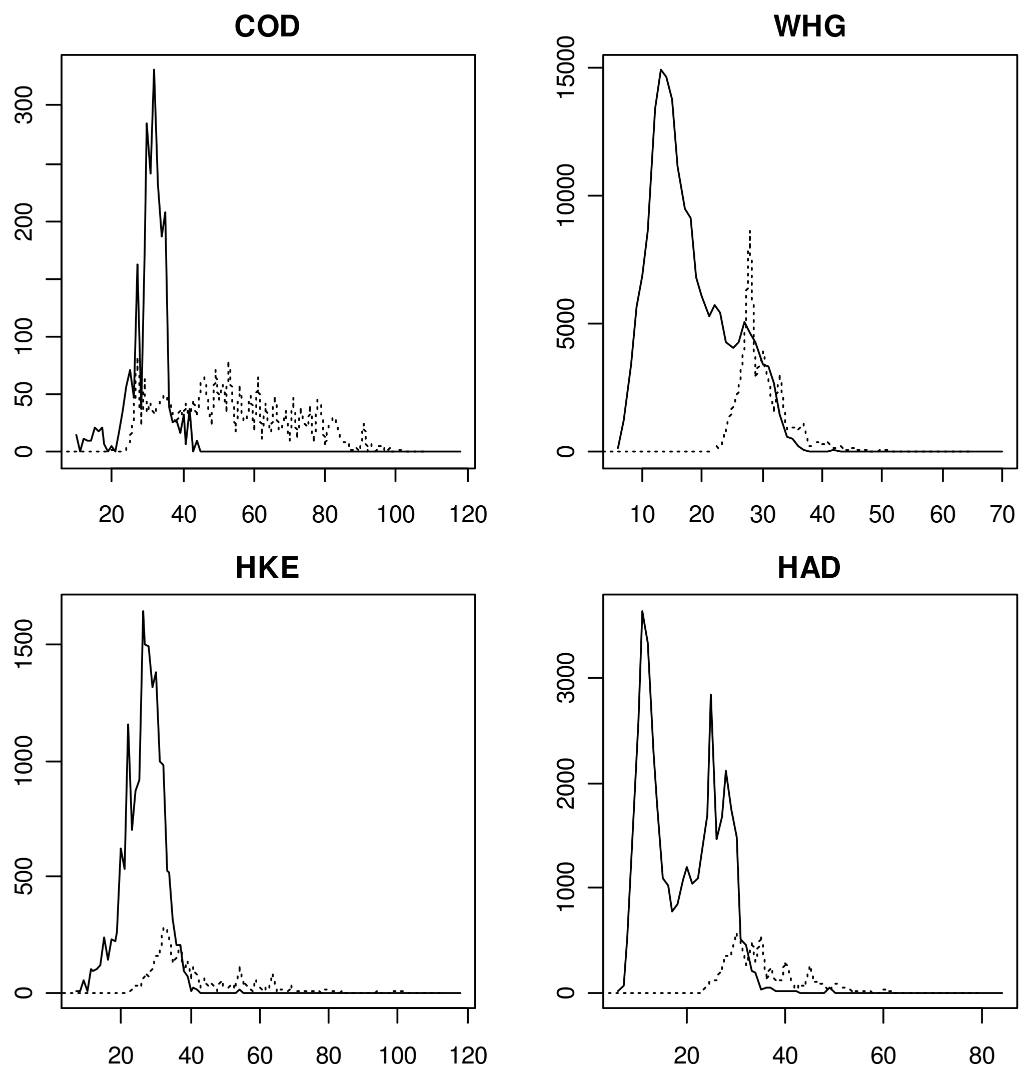


Figure 25. Left plots show the modelled proportion of the number of whiting at length caught in trawls with modifications tested in the North Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Grey shaded area is area of significance around the modelled fit. MLS = minimum landings size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

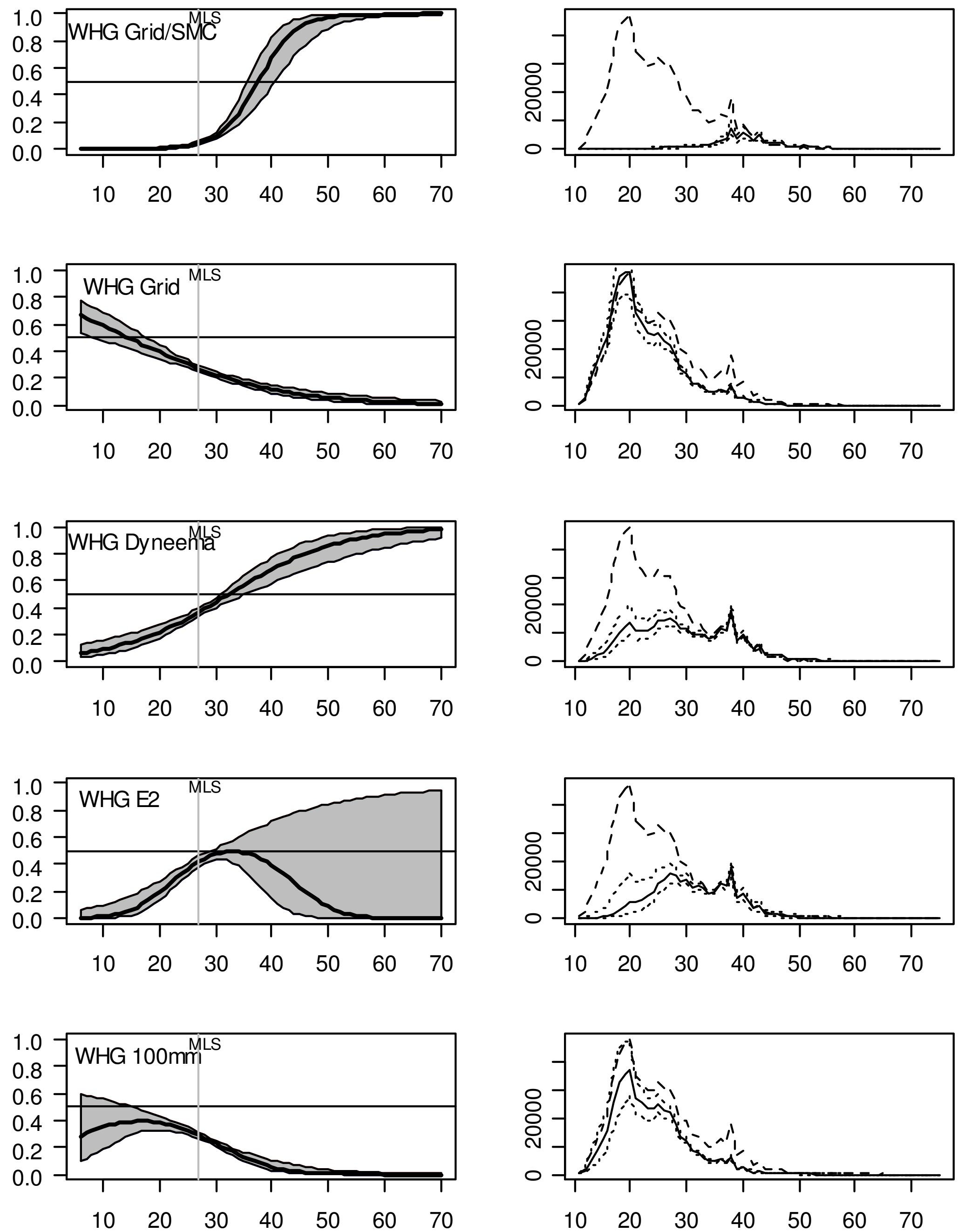


Figure 26. Left plots show the modelled proportion of the number of whiting and haddock at length caught in trawls with one modification tested in the Irish Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Grey shaded area is area of significance around the modelled fit. MLS = minimum landing size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

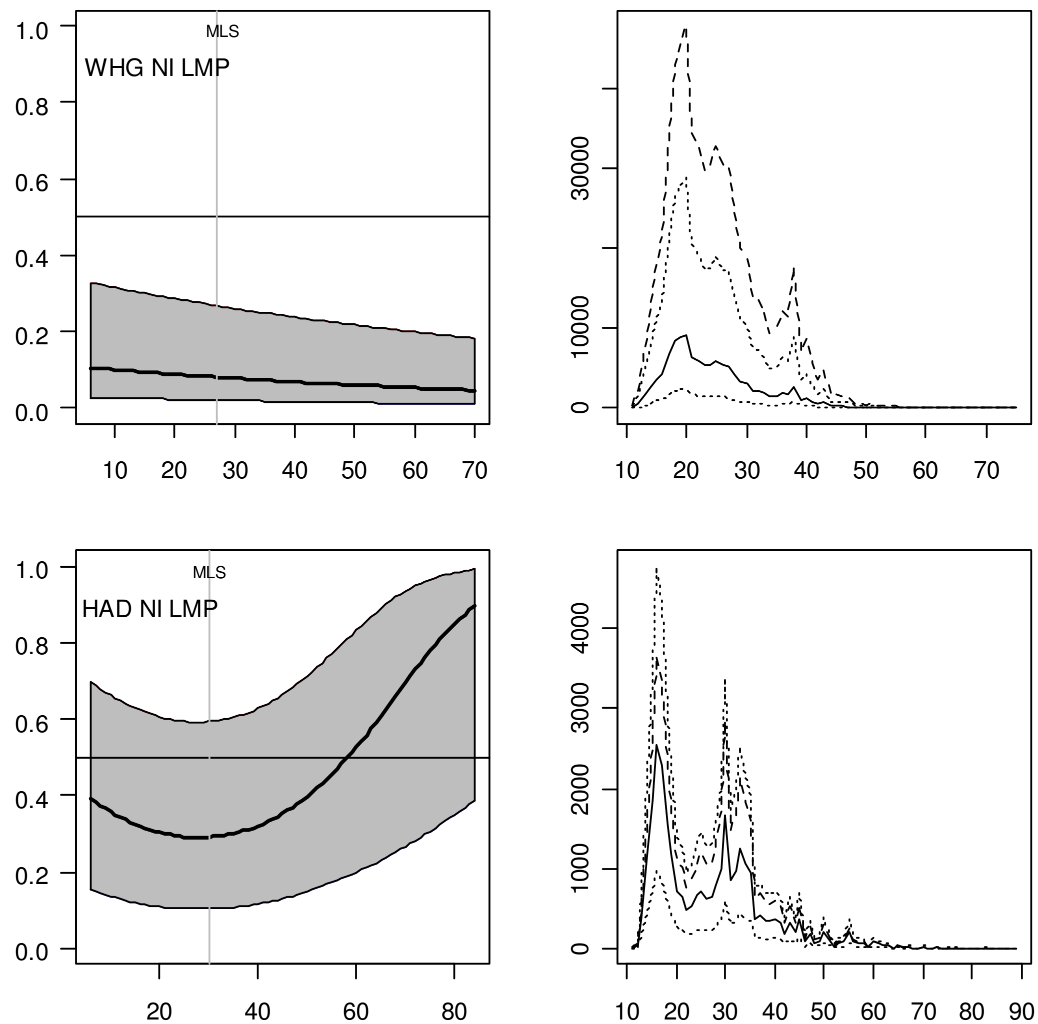


Figure 27. Left plots show the modelled proportion of the number of whiting, haddock and hake at length caught in trawls with an inclined separator panel (version 1) in the Irish Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Grey shaded area is area of significance around the modelled fit. MLS = minimum landing size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

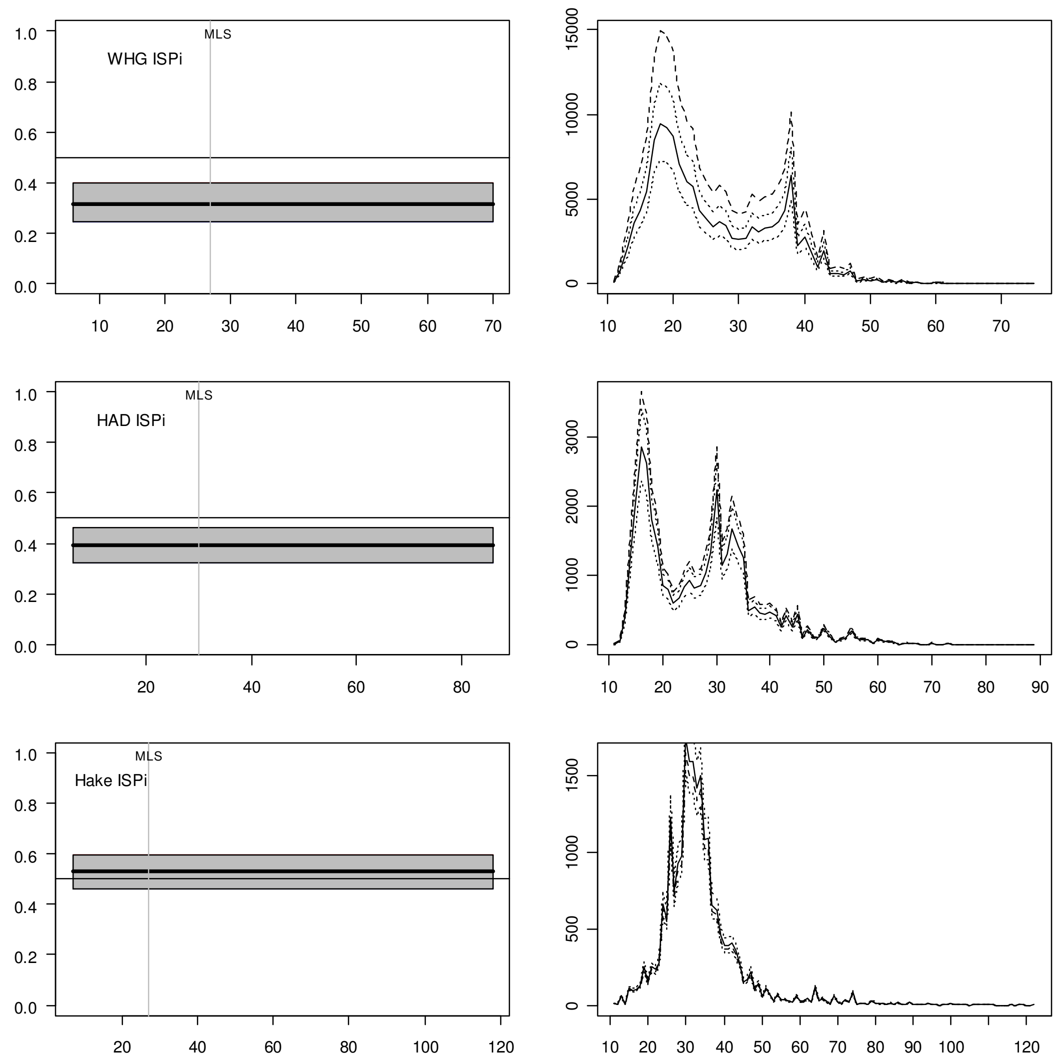


Figure 28. Left plots show the modelled proportion of the number of whiting, haddock and hake at length caught in trawls with an inclined separator panel (version 2) in the Irish Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Two trials were conducted and were analysed separately. Grey shaded area is area of significance around the modelled fit. MLS = minimum landing size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

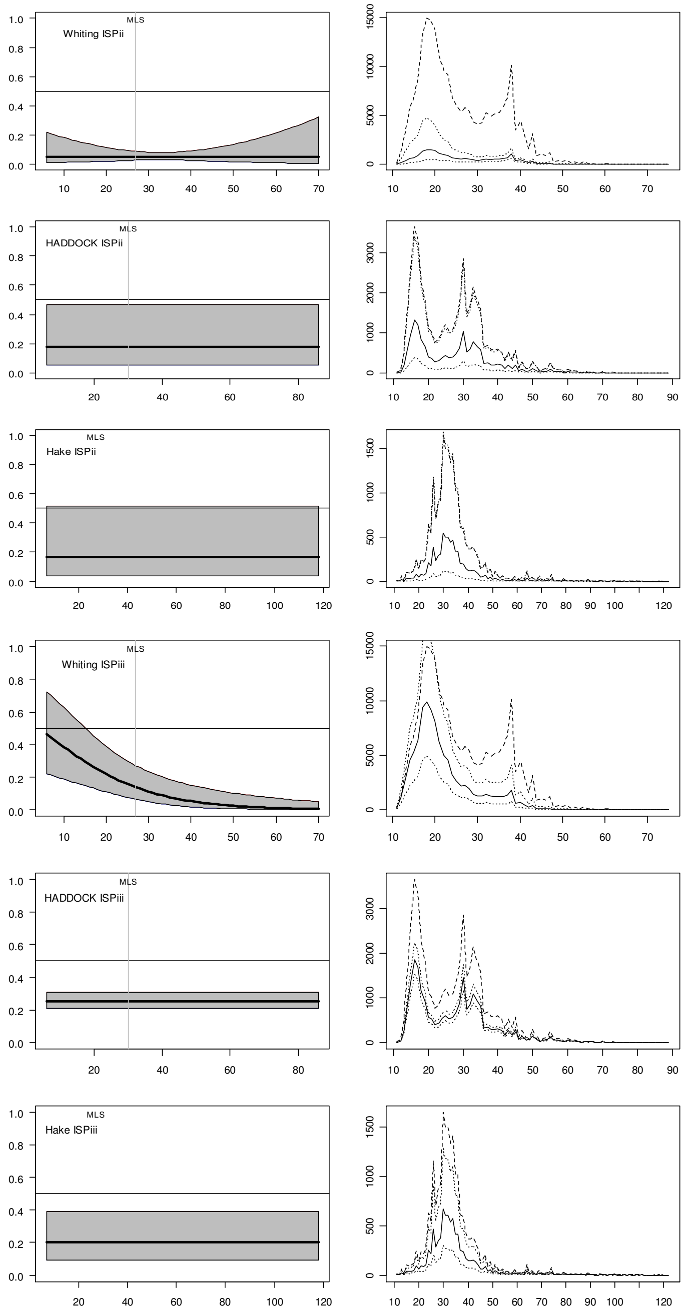


Figure 29. Left plots show the modelled proportion of the number of whiting, hake and haddock at length caught in trawls with large mesh wings in the Irish Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Two trials were conducted and were analysed separately. Grey shaded area is area of significance around the modelled fit. MLS = minimum landing size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

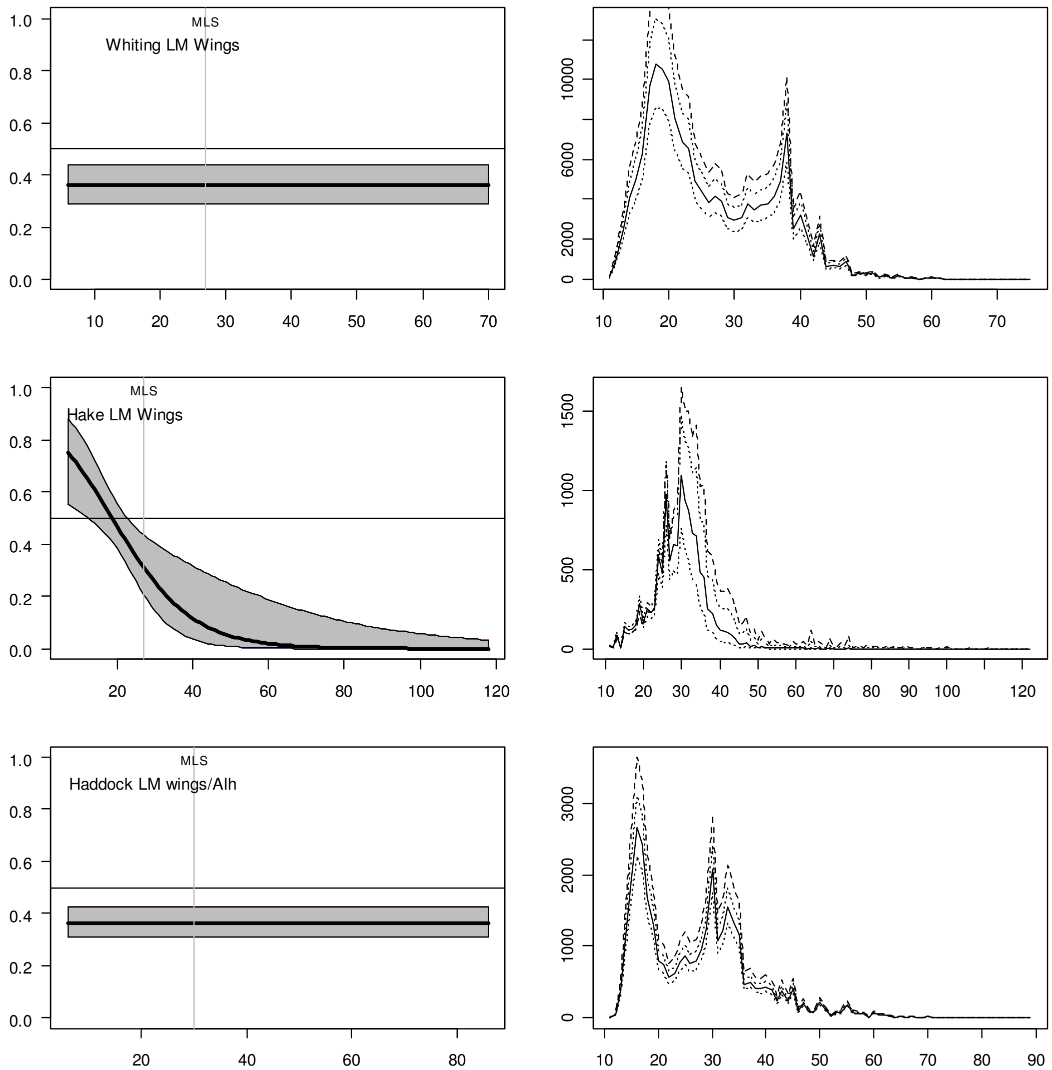


Figure 30. Left plots show the modelled proportion of the number of whiting and hake at length caught in a coverless trawl (cutaway) in the Irish Sea relative to the total in both a conventional trawl and a trawl with a modification (i.e. 0.5 indicates an equal number caught in both trawls). Two trials were conducted and were analysed separately. Grey shaded area is area of significance around the modelled fit. MLS = minimum landing size. Right plots give catch length frequency from the sampled trips (dashed line) and the predicted change in catch length frequency with the use of a gear modification (solid line, with area of significance as dotted line).

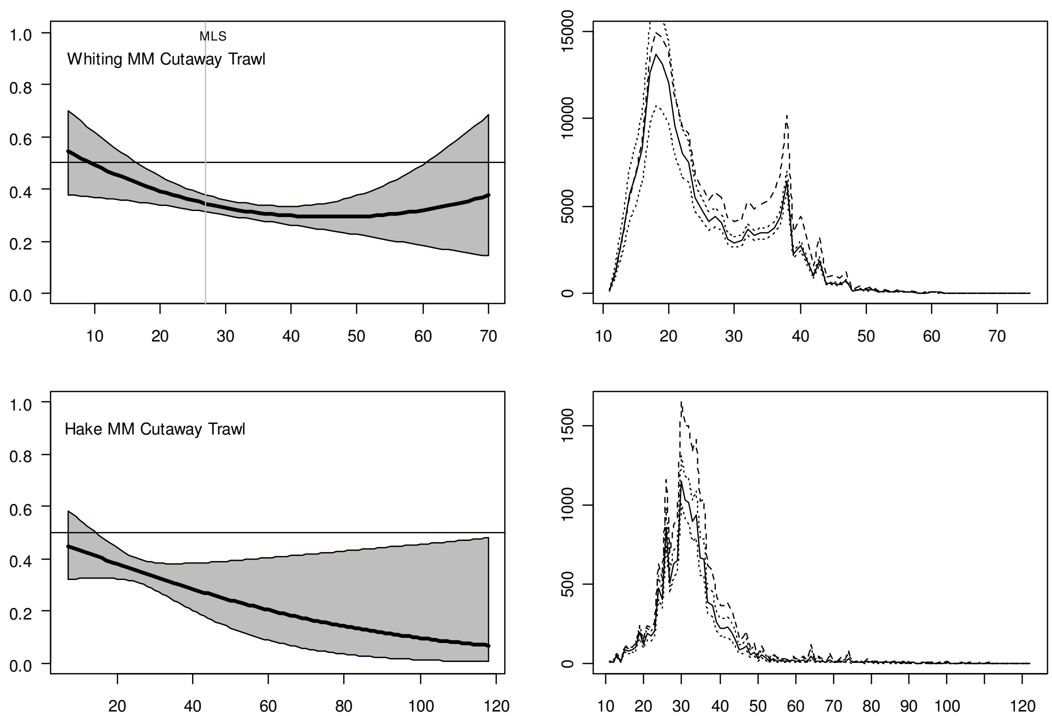


Table 12 The percentage reduction in number of discards, the predicted discard rate, percentage reduction in landings by number and reduction in overall percentage contribution to the discards in all fish by number that is predicted to occur with the introduction of trawl modifications, the range is given in brackets and is calculated from the limits of significance from the catch comparison models. Trawl modifications: GridSMC = selection grid with square mesh codend, Grid = selection grid, ThinSMP = thin high-strength knotless square mesh panel, E2 = double square mesh panel, LMP = large diamond mesh panel in topsheet, ISPi = inclined separator panel version 1, ISPii = inclined separator panel version 2 (two separate trails), LWP = large diamond meshes in wings, CLESS = coverless trawl.

Trawl mod.	Species	% Reduction in discard number	Predicted discard rate	% Reduction in landings number	Reduction in % contribution to discards of all fish
	WHG	**(current estimated discard rate 84%; contribution to total fish discards 19%)**			
GridSMC	WHG	97 (96-98)	26 (25-29)	33 (14-52)	18
Grid	WHG	13 (0-26)	95 (95-95)	65 (60-70)	2
ThinSMP	WHG	59 (48-68)	75 (73-78)	-11 (-24-2)	11
E2	WHG	68 (51-76)	75 (74-76)	10 (-22-34)	13
100mm	WHG	86 (57-94)	54 (46-74)	7 (-25-46)	16
LMP	WHG	81 (41-95)	91 (91-91)	85 (50-96)	15
ISPi	WHG	36 (20-51)	87 (87-87)	36 (20-51)	7
ISPii	WHG	89 (73-95)	87 (82-91)	89 (82-94)	17
ISPii	WHG	49 (12-75)	95 (94-96)	84 (64-94)	8
LMW	WHG	27 (12-42)	87 (87-87)	27 (12-42)	4
CLESS	WHG	17 (2-31)	90 (89-91)	38 (31-44)	3
	HAD	**(current estimated discard rate 87%, contribution to total fish discards 5%)**			
LMP	HAD	36 (-24-77)	86 (86-86)	32 (-29-75)	2
ISPi	HAD	21 (-7-35)	86 (86-86)	21 (-35-7)	1
ISPii	HAD	63 (6-86)	86 (86-86)	63 (6-86)	3
ISPii	HAD	49 (38-58)	86 (86-86)	49 (38-58)	3
LMW	HAD	27 (15-38)	86 (86-86)	27 (15-38)	1
	HKE	(current estimated discard rate 83%, contribution to total fish discards 2%)			
ISPii	HKE	66 (2-92)	83 (83-83)	66 (2-92)	1
ISPii	HKE	66 (2-92)	83 (83-83)	66 (2-92)	1

LMW	HKE	35 (-30-34)	99 (98-99)	81 (44-93)	1
CLESS	HKE	30 (19-41)	87 (83-89)	48 (21-66)	0

***Nephrops* fishery**

The analysis aimed to quantify the potential for reducing discard rates through modifications to the design of *Nephrops* trawls. Models were applied for whiting, hake and haddock, which make up 25% of the estimated number of discarded fish and have discard rates in excess of 80% by number. However, a total of 160 fish species have been identified as being caught and discarded in this fishery, therefore, having serviceable models for only a few species limited the scope of this analysis. In particular it cannot be determined to what extent the discard rate of all species sampled can be affected by the various trawl modifications. Predicted changes in discard rates are presented for three species analysed but none of these have been selected as indicator species for the fishery. It was possible however, to determine the contribution to reducing discard rates for all species made by the changes to catch patterns of whiting, haddock and hake. The range in modelled outcomes is considerable but the data suggests that discard rates for all species can be reduced by around 15% when taking into account only the effect on whiting, haddock and hake. It is likely that the modifications investigated would alter the catch patterns of other species and further reduce overall discard rates. The analysis demonstrates that a substantial reduction in discarding is technical feasibility; however, it cannot be determined whether the associated loss in landings will allow the continuation of a viable fishery.

Simulations from the Scottish data clearly show that gear modifications can provide significant reductions in the retention of fish at length, yet if fished in areas with high concentrations of juveniles, the relative reductions in the rate of discards can be far less obvious. This is a significant point, particularly in times of strong recruitment which may make achieving modest reductions in species specific discard rates problematic.

10. ECONOMIC IMPACT

It was not possible to estimate the economic impact on the relevant fleets of achieving the discards targets in the selected fisheries. This was due primarily to missing and inaccurate data and that available fleet economic data was aggregated to segment level.

It is possible to conclude, based on the conclusions of the technical sub-group, that all potential measures currently available to reduce discards will have a negative economic effect for vessels adopting them, in the short and medium term. If vessel businesses adopt new measures to achieve the targets of by-catch reduction, then it appears that in the short and medium term, they will be less profitable as a result. It is not possible to comment on whether in the longer term, reduction in discards would lead to higher catch rates.

Attempts were made to estimate potential economic impacts of adopting discards reduction measures for some of the fleet segments involved in the two fisheries. It should be made clear that these are estimated impacts of adopting the measures, rather than impacts of imposing the regulations, since there is no certainty that the imposition of the regulation will lead to any change in behaviour on board vessels.

10.1. Economics data availability comments

The data available at the working group was the 2006 DCR data, provided by the Commission. There were several issues with data availability which ultimately made it impossible to fulfil TOR 3, assess the economic impact of the progressive reduction of discards in the two fisheries. These issues are articulated in table 13.

The issues were:	Implications
1. The fleet segments are too broad and in many cases include more than one métier of vessel which have quite different fishing patterns.	It is not possible to model accurately with data aggregated in this way. For a segment show a loss overall, it is not possible to tell how many, if any, vessels were actually turning a profit.
2. Many segments which are involved in the two fisheries had no economic data	It is not possible to estimate the overall economic impacts of adopting by-catch reduction measures because there are some fleet segments for which we cannot make estimates.
3. There were some apparent errors in some segments which meant that we could not use data for those segments (e.g. most of the Belgian TBB segments had a negative figure for breakeven revenue)	As above
4. For many segments, it was not possible to determine how the figure for income was achieved – the income figure was in some cases lower than the sum of fish landings value, which suggests some inaccuracy.	As above

Table 13. Data quality issues associated with the available economic information.

For impact on the wider economy, there are no appropriate input-output multipliers or other models available to use.

10.2. Method for estimating fleet financial impact

In reality, the impacts of imposing the discard reduction targets and regulations, will depend entirely on how vessel business managers choose to respond to the regulations. These choices cannot be predicted.

Instead, the working group identified some potential choices of measures to reduce unwanted by-catch in each fishery.

In outline, the economists aimed to compare a baseline year with no discards regulations to the estimated financial outcomes of fishing in the same year, under the discard regulations, taking account of changes to operating costs, fishing income and investment requirements.

It would also have been ideal to consider immediate and medium term impacts, with some qualitative reference to the longer term, how this was not possible due to time constraints.

In order to make the comparisons, costs and earnings tables for relevant fleet segments in the two fisheries with available and reliable-looking data were prepared and compared to costs and earnings tables reflecting various discard-reduction scenarios, applying to the same year.

10.2.1. Estimating the baseline year costs and earnings

The baseline year was taken to be 2008 and baseline costs and earnings tables were prepared using the 2006 DCR data and 2008 TACs and fuel prices to create forecast annual outcomes for 2008.

Baseline year earnings were based on 2006 prices applied to estimated landings of the top five species shown in the DCR data. The 2008 estimated landings were calculated by taking the 2006 segment landings as a proportion of the appropriate MS TAC and applying that proportion to the 2008 TACs.

For crew costs in the baseline year, application of the standard approach to calculating crew share (gross earnings minus fishing costs multiplied by 0.4 to 0.5) gave unreasonably low amounts or even negative amounts, because of the very high fuel costs. Therefore, for all but two segments we assumed that crew costs would only fall to 0.8 of 2006 values, and no further, because otherwise crew members would exit to other employment opportunities, if their remuneration were to fall below this level. We recognise that this is a fairly crude assumption, but could not simply reduce crew share to zero and expect the business to continue to function.

For two segments, the Netherlands TBB VL2440 and Netherlands TBB VL40XX, we took industry advice that €30,000 would be the minimum acceptable per crewman per year and that there are typically 6 crew on board. This seemed reasonable advice, so for those two segments we imposed a €180,000 annual crew cost, which was higher than the traditional method would have given but lower than 80% of 2006 figure.

For fuel costs we assumed that annual average fuel price per litre has doubled in 2008 compared to 2006, and that vessel owners have adopted fuel efficiency measures which have reduced their consumption over the year by 20%. This fuel use reduction assumption is based on a report into uptake of fuel efficiency options by Seafish1 and advice from a Netherlands industry representative.

All other costs were assumed to have increased by 3% since 2006.

10.3. Fleet financial impacts of discard reduction measures

In the scenarios with altered gear leading to altered catch levels, and no other change in practice, the only change in financial outcomes is a reduction in earnings level.

Whereas under normal circumstances, this would lead to a reduction in crew-cost (or crew share), in these scenarios, our baseline situation was already so unprofitable that the crew were receiving our imposed minimum crew-share, so no further reductions were applicable, given our assumptions about uptake of other employment opportunities.

10.3.1. Nephrops Fishery Area VII

For the *Nephrops* fishery the economics subgroup chose four segments with the most reliable data sets:

Segment 1: Ireland DTS VL1224

Segment 2: Ireland DTS VL2440

[1] Curtis, H. *et al.* Options for improving fuel efficiency in the UK fishing fleet. Seafish. 2006.

Segment 3: UK DTS VL0012

Segment 4: UK DTS VL1224.

Scenario 1: Introduce a special sorting grid that results in a move from a multi-species to nearly a one-species fishery. Leads to no change in operating costs, reduction of 75 – 100% of all catches besides *Nephrops*, and no reduction in *Nephrops* catch. Investment required is cost of new nets.

Assessment: this scenario is not economically feasible.

Scenario 2: Gear technical measure that reduces landings of round fish by 25% and no change in *Nephrops* landings.

Assessment: this scenario is feasible.

Table 14 Segments analysed with results of various scenarios

Nephrops	2006 DCR (for info)	Baseline (2008)	Scenario 1	Scenario 1 diff. from baseline	Scenario 2	Scenario 2 diff. from baseline
Ireland DTS VL1224: **Segment** (mEUR)						
Income	49.49	51.80	28.84	-22.96	50,25	-1.55
Profit	-5.12	-7.99	-30.94	-22.95	-9,54	-1.55
Value added	14.67	2.44	-20.51	-22.95	0,90	-1.55
requ. Investment	n/a	0	n/a		n/a	
Ireland DTS VL1224: **Avg Vessel** EUR						
Income	307,000	322,000	179,000	-143,000	312,000	-10,000
Profit	-32,000	-50,000	-193,000	-143,000	60,000	-10,000
Value added	91,000	15,000	-128.000	-143,000	5000	-10,000
requ. Investment		0	4,000		n/a	
Ireland DTS VL2440: **Segment** (mEUR)						

Income	39.59	40.80	11.17	-29.63	39.92	-0.88
Profit	1.35	-0.49	-30.12	-29.63	-1.37	-0.88
Value added	17.76	9.59	-20.04	-29.63	8.71	-0.88
requ. Investment	n/a	0	n/a		n/a	
Ireland DTS VL2440: **Avg Vessel**						
EUR						
Income	966,000	995,000	272,000	-723,000	974,000	-21,000
Profit	33,000	-12,000	-735,000	-723,000	-33,000	-21,000
Value added	433,000	234,000	-489,000	-723,000	213,000	-21,000
requ. Investment	n/a	0	4,000		n/a	
UK DTS VL0012: **Segment**						
(mEUR)						
Income	31.37	34.01	19.56	-14.45	32.82	-1.19
Profit	2.92	4.48	-9.97	-14.45	3.29	-1.19
Value added	13.31	11.37	-3.08	-14.45	10.18	-1.19
requ. Investment	n/a	0	n/a		n/a	
UK DTS VL0012: **Avg Vessel**						
EUR						
Income	72,000	78,000	45,000	-33,000	76,000	-3,000
Profit	7,000	10,000	-23,000	-33,000	8,000	-3,000
Value added	31,000	26,000	-7,000	-33,000	23,000	-3,000
requ. Investment	n/a	0	4,000		n/a	
UK DTS VL1224: **Segment**						
(mEUR)						
Income						

Profit	196.05	206.91	99.91	-107.00	189.66	-17.25
Value added	13.75	13.30	-93.70	-107.00	-3.95	-17.25
requ. Investment	67.22	51.49	-55.51	-107.00	34.24	-17.25
	n/a	0	n/a		n/a	
UK DTS VL1224:						
Avg Vessel						
EUR						
Income	387,000	408,000	197,000	-211,000	374,000	-34,000
Profit	27,000	26,000	-185,000	-211,000	-8,000	-34,000
Value added	133,000	102,000	-109,000	-211,000	68000	-34,000
requ. Investment	n/a	0	4,000		n/a	

10.3.2. Beam trawl fishery Area IVI and VIId

For the beam trawl fishery the economics subgroup chose four segments with the most reliable data sets:

1. Netherlands TBB VL1224
2. Netherlands TBB VL2440
3. Netherlands TBB VL40XX
4. UK TBB VL2440
5. UK TBB VL40XX

Scenario 1: Adopt a mesh size of 90mm. Leads to no change in operating costs, reduction in sole landings by 14% and in plaice landings by 1%. Investment required is cost of new nets.

Assessment: this scenario is not economically feasible.

Scenario 2: Adopt a mesh size of 100mm. Leads to no change in operating costs, reduction in sole landings by 32% and in plaice landings by 2.5%. Investment required is cost of new nets.

Assessment: this scenario is not economically feasible.

Table 15 Segments analysed with results of various scenarios

Beam Trawl	2006 DCR (for info)	Baseline (2008)	Scenario 1	Scenario 1 diff. from baseline	Scenario 2	Scenario 2 diff. from baseline
Netherlands TBB VL1224: **Segment** (mEUR)						
Income	58.37	56.33	55.58	-0.74	54.63	-1.70
Profit	-3.65	-10.44	-11.18	-0.74	-12.14	-1.70
Value added	25.93	5.38	4.64	-0.74	3.68	-1.70
requ. Investment	n/a	0				
Netherlands TBB VL1224: **Avg Vessel** EUR						
Income	312,000	301,000	297,000	-4,000	292,000	-9,000
Profit	-20,000	-56,000	-60,000	-4,000	-65,000	-9,000
Value added	139,000	29,000	25,000	-4,000	20,000	-9,000
requ. Investment	n/a	0	?			
Netherlands TBB VL2440: **Segment** mEUR						
Income	46.57	41.76	39.98	-1.78	37.67	-4.08
Profit	-2.70	-16.87	-18.66	-1.78	-20.96	-4.08
Value added	15.47	-9.34	-11.09	-1.78	-13.40	-4.08
requ. Investment	n/a					
Netherlands TBB VL2440: **Avg Vessel** EUR						
Income	1,109,000	994,000	952,000	-42,000	896,953	-97,000

Profit	-64,000	-402,000	-444,000	-42,000	-499,000	-97,000
Value added	368,000	-222,000	-264,000	-42,000	-319,000	-97,000
requ. Investment	n/a		?			
Netherlands TBB VL40XX: **Segment**						
mEUR						
Income	131.31	117.55	109.56	-8.00	99.22	-18.34
Profit	-5.6	-44.62	-52.64	-8.00	-62.98	-18.34
Value added	40.61	-29.52	-37.52	-8.00	-47.86	-18.34
requ. Investment	n/a	n/a				
Netherlands TBB VL40XX: **Avg Vessel**						
EUR						
Income	1,563,000	1,399,000	1,304,000	-95,000	1,181,000	-218,000
Profit	-67,000	-531,000	-627,000	-95,000	-750,000	-218,000
Value added	483,000	-351,000	-447,000	-95,000	-570,000	-218,000
requ. Investment	n/a					

Beam Trawl	2006 DCR	Baseline (2008)	Scenario 1	Scenario 1 diff. from baseline	Scenario 2	Scenario 2 diff. from baseline	Scenario 3	Scenario 3 diff. from baseline
UK TBB VL2440: **Segment**								
mEUR								
Income	40.93	40.47	39.60	-0.87	38.47	-2.00		
Profit	1.95	-6.28	-7.15	-0.87	-8.28	-2.00		
Value added	13.06	-0.17	-1.05	-0.87	-2.17	-2.00		
requ. Investment								
UK TBB VL2440: **Avg Vessel**								
EUR								
Income	787,000	778,000	762,000	-17,000	740,000	-38,000		
Profit	38,000	-121,000	-137,000	-17,000	-159,000	-38,000		
Value added	251,000	-3,000	-20,000	-17,000	-42,000	-38,000		
requ. Investment								
UK TBB VL40XX: **Segment**								
mEUR								
Income	24.89	24.45	23.92	-0.53	23.23	-1.22		
Profit	-4.42	-12.66	-13.19	-0.53	-13.88	-1.22		
Value added	3.2	-9.96	-10.49	-0.53	-11.18	-1.22		
requ. Investment								
UK TBB VL40XX: **Avg Vessel**								
EUR								
Income	1,659,000	1,630,000	1,594,779	-35,000	1,549,000	-81,000		
Profit	-295,000	-844,000	879,000	-35,000	-925,000	-81,000		
Value added								

requ. Investment	213,000	-664,000	-699,000	-35,000	-745,000	-81,000		

10.3.3. Incentive to try to achieve the targets

The economics sub-group felt it was important to note that since there are no positive incentives to change business practices and adopt measures to reduce by-catch or discards, then the sanctions for failing to achieve the target rates become the only reason to change behaviour. It is therefore essential, in order to achieve a change in practice, to ensure that the sanctions will apply to those vessel owners not reaching the target and that the sanctions will be more costly to the business than the cost of adopting the discard reduction measures.

Individual business owners will calculate the likely cost of achieving the targets and compare that cost to the likely sanction.

Under the new EFF it is possible to pay vessel owners for changing to the use of more "environmentally friendly" fishing gear. This can be seen as a possibility for a positive incentive if MS include these payments in their national allocation scheme of the EFF. But these funds are only covering the investment costs. The calculations in this report show that this is not sufficient because of the loss of income following changes in landings. Uncertain are also higher landings in the future by avoiding bycatch of juveniles today. Studies are needed to collect data on real costs of avoiding discards (changing fishing grounds, storage costs, sorting costs etc.). With these data it may be possible to calculate losses and necessary payments. However, it is problematic to argue in favour of a new subsidy to reduce discards. Nevertheless, paying producers for ecological services and the avoidance of negative external effects, needs consideration. There are wide differences in the amount of negative external effects in fisheries. Today mainly the most cost-efficient fishing methods prevail and methods avoiding external effects are uncompetitive.

11. SOCIAL IMPACT OF PROGRESSIVE REDUCTION OF DISCARDS (TOR4).

No data or experts were available at the meeting to carry out specific social assessments.

The economics sub-group make the following comments:

As it has been concluded that discard reduction measures will make vessel businesses less profitable, then it can be expected that there will be some losses of crew jobs, reductions in crew earnings and returns on investment and some business failures. In current circumstances, those segments with higher relative fuel costs – such as beam trawling – will inevitably be more vulnerable to business failure.

12. DISCUSSION

For both fisheries, a range of potential discard mitigation tools are available now to reduce discards to the initial aggregated (all species) rates specified in the Commission discussion paper within the defined target period e.g. two years. This is conditional on full utility by the industry supported by adequate control, enforcement and monitoring. While the technical feasibility is clear, the ability of the two sectors to absorb the associated additional costs (gear modifications, losses of commercial species, increased fuel consumption) is doubtful given the current economic climate. One possible exception are métiers that primarily target *Nephrops*, so reductions in fish by-catch may be economically viable, although not necessarily acceptable at a business level due to potential losses in revenue. However, it was not possible for the sub-group to appraise this fully due to the aggregated nature of the economic data. For the beam trawl fleet, it is clearly evident that its ability to absorb further costs will simply add to the net operating losses currently being experience by this fleet.

The sub-group note that despite the range of mitigation measures being available for many years, discarding is still prominent in the two fisheries investigated. In general terms, the target based approach is considered a welcome measure to encourage, albeit through negative incentives, reductions in these and potentially other fisheries. The sub-group concludes that whilst the initial targets (<3 years) are technically feasible (although not economic in most cases) it did not feel confident in commenting on whether the final targets are. This is dependant on new developments that may arise in the future and the economic viability of the two sectors in general, particularly the beam trawl fleet. The final target levels should be viewed as aspirational, but given the currently available technology and knowledge base, such targets will not be achieved without a significant and unsustainable economic impact on the two fleets. This should be reviewed in the light of new techniques becoming available, it is therefore recommended that both the targeted reductions an rates be reviewed periodically.

To maximise the benefits of the target based approach, it is necessary to internalise the costs associated with failing targets (e.g. sanctions) at an individual business (vessel) level. This is likely to prevent or dilute cooperative métier or fleet approach to meet an agreed target as individual businesses may gain a significant economic advantage through inaction (no commercial losses) over those who adjust their individual behaviour to achieve a common goal. The sub-group conclude that in order to provide an equitable environment, sanctions should be imposed at a business level. This will require that monitoring be at sufficiently high level. While this is primarily a control issue, the sub-group felt that this is central to the effectiveness of the overall approach.

The ability of the sub-group to provide anything other than an indicative outcome of the target based approach is due largely to the limits of the available data. Baseline estimates have been derived form information collected under the data collection regulation, which is not structured to provide this type of information, in terms of either the discard levels or economic impact at métier levels. Such programmes are designed to provide data at the aggregation of a stock or fleet segment and therefore preclude analysis at a fishery level. It needs to be acknowledged that the discard baseline levels are based on typically less than 1% of the overall fleet effort and are therefore likely to be imprecise and are subject to a high degree of variability. Estimates that are more precise will only become available with significant increases in sampling levels. The sub-group note while it is desirable to provide more precise baseline estimates for the two fisheries concerned, it also recognises the need to commence with the programme, but notes that in the absence of more robust data, the baselines identified are subject to question. Discard rates between métiers within each fishery vary widely. To support the implementation of the policy, it is necessary that an appropriate fleet monitoring programme is introduced as a matter of urgency and is conditional to the success of the policy is conditional upon this. The monitoring programme needs to be conducted with a systematic approach across all MS. This requires that standardised data collection and methodology (SOP) is agreed prior to the commencement of the policy. Failure to do so will result in data compatibility issues between MS, particularly those engaged in the same fishery. The design and structure of the monitoring programme is considered to be of significant importance and needs to be addressed as soon as practically possible. This centralised function is critical and raises complex challenges that are best considered by an appropriate expert group convened either under the auspices of STECF or ICES. The latter may be more appropriate given the expectation that ICES is likely to play some role in assessing the integrity of the data produced under this policy.

Monitoring the effectiveness of the policy will be of critical importance. This is not only to ensure the accurate collection and analysis of data across very different fishing métiers but also to ensure that there are no perverse impacts of policy. This can apply particularly where inadequately researched technical measures merely move discarding from where it can be quantified with relative ease – on board fishing vessels – to more problematic locations within fishing gears: selecting fish out of towed gears is known to result in significant mortality but the extent can be hard to quantify to any degree of accuracy.

13. CONCLUSIONS

The target based approach if implemented fully, will promote the reduction of overall discard rates (all species combined) in the two fisheries identified. The first level of reductions (all species combined) is likely to be technically achievable with current tools.

Achieving similar reductions for individual species indicators (i.e. plaice and *Nephrops*) are likely to be more problematic and have a greater economic impact if they are to be achieved at a similar level and rate.

Individual métiers within the two general fisheries definition area likely to have differing discard patterns. Data aggregation and differences between collection programmes preclude detailed analysis at a fishery defined in the consultation document.

The fishery definitions are broad and likely to obscure métier dependant discard patterns. For the effective implementation of policy monitoring and remedial intervention should be done at a métier level for maximum impact.

The baseline measurements for both fleets are based on data collected under programmes that are not designed to provide precise data on discard rates across aggregated fisheries and Member States and typically only cover <1% of the total effort.

Target levels should be based on discard rates aggregated across fish and shellfish species and not include benthos. The use of fishery-specific indicator species should also be considered.

It is not possible, with any degree of certainty, to determine if the longer term targets (> 3 years) set out in the consultation paper are practically or economically achievable.

Target levels should be based on numbers rather than weights discarded, as this will provide the best overall conservation benefits

The issue of targets and the assessment of progress should be subject to appropriate mid-term review involving expertise including statistical analyses. Multi-annual rather than annual targets are more likely to be achievable from a practical perspective as this allows more time to develop and test methodologies.

Compliance with discard rates could be achieved through landing species that are not subject to current legal limits i.e. lack of MLS or species not subject to TAC. This will dilute potential stock and ecosystem benefits.

It is important to find mechanisms to ensure that some vessels cannot obtain a commercial advantage over others by failing to limit their own discards.

The effective implementation of this policy is dependent upon fishermen's ability to undertake gear modifications that will make generic technical conservation measures appropriate to their individual circumstances. This will require a degree of 'relaxation' of the current TCM regime and a greater willingness than hitherto demonstrated by regulating authorities to allow derogations from those TCMs.

The current aggregation of economic data collated under the DCR precludes quantifying the economic consequences at a métier level within the overall fishery description. It is possible that the economic viability within the fisheries definition is variable.

It is necessary to establish a standardised sampling, monitoring programme and agreed raising procedures across Member States

The risk of fishing mortality merely moving to another location in the fishing operation must be accommodated by further research and robust monitoring into currently unquantified mortality.

14. RECOMMENDATIONS

To assess the impact of the policy it is necessary that discard data be collected at a métier level and with appropriate data for raising metrics to determine the absolute changes in discard levels.

While discard rates are relatively simple to monitor, the success of the discard reduction policy should be based on absolute reductions. Using rates alone can obscure significant gains in reducing discards at an absolute level and are sensitive to variability in recruitment strength.

A group should be set up to define standard sampling, monitoring and data raising methodologies at appropriate métier levels and these should be applied across all Member States.

A mid term review should be conducted to assess the initial success of the policy and propose changes to targets in light of new information if necessary.

Future testing of mitigation tools should make provision to assess the impact on non-commercial species.

The industry needs to be provided with timely, periodic data from monitoring programmes to determine how effective their measures are in achieving the goals so that they have sufficient temporal scope to adjust if further adjustments are required.

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