Marine Management Organisation

Catch Quota Trial 2012: Final report

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Contents

Tables

Figures

Amendments

Date	Details of change
19 July 2013	Correct version of Table 4 with new figures for number of trips and average analysis time for each trip for beam trawl, beam trawl (4 species) and beam trawl (5+ species).

Executive summary

This report provides the results of pilots carried out by the Marine Management Organisation (MMO) and fishing industry participants during 2012. The pilots were commissioned by the Department for Environment, Food and Rural Affairs (Defra).

The project resides in the context of a key element of the European Common Fisheries Policy (CFP) reform proposals. A key objective of the reforms is to eliminate discards and significantly reduce unwanted catches of fish at sea.

It is anticipated a reformed CFP (2014) will introduce a need to ensure greater accountability for catches and a greater responsibility for industry to keep fishing mortality within sustainable limits through the prohibition of discarding. With this in mind these pilots have trialled a catch quota system for certain stocks, which accounts for total catches rather than quotas only for what is landed by fishing vessels. Discards of fish from stocks monitored under the trial were prohibited.

A key objective of the trial, following on from trials in 2011, was to collect evidence on the potential impacts of discard bans on industry and regulators, particularly in mixed fisheries where detailed rules for the implementation of a landing obligation need careful consideration. The development of CCTV as a monitoring tool and analysis methodologies in the context of full catch documentation and other data collection requirements was also undertaken.

Participating English-administered vessels were fitted with remote electronic monitoring equipment with CCTV (EM), supplied by Archipelago Marine Research Ltd (AMR). Participants were provided with additional quota in line with EU quota regulations for fully documented fisheries, as agreed by the Council of Ministers in November and December 2011. Additional quota was administered by the MMO through fish producer organisations to ensure the uptake of extra quota remained within the pool of participant vessels. Additional days at sea were also provided to North Sea participants to allow for flexibility to use more time at sea in order to avoid areas of high juvenile fish abundance. The number of participant vessels increased from 15 in 2011, to 19 in 2012.

Amendments to the Council regulation on total allowable catches (TACs) and quotas in 2012 provided an opportunity for participation in trials for a wider range of stocks for which additional quota was available. These stocks included high discard fisheries such as ICES area VIIb-k haddock. The offer of a gift of North Sea plaice quota by Norway also presented an opportunity to test CFP reform proposals in a fishery where high discards have been observed. However, potential applicants to the scheme cited an arbitrary 30% cap on additional quota opportunity as set out in the regulations (Article 7 2 (b) of Council Regulation 43/2012 for internal TACs and quotas and Article 8 2(b) of Council Regulation 44/2012 for external TACs and quotas) as the key reason for their non-participation for these fisheries.

The trial has recorded a total catch of 1,180 tonnes of catch quota species. A total discard rate for combined species under trial was estimated at 0.3% of the total catch – just over 3 tonnes for the year.

Undersized or otherwise unmarketable catch quota species were landed and disposed of to non-human consumption outlets for bait and fishmeal. This amounted to 9.6 tonnes or 0.8% of total landings.

A total of 7 quota stocks were monitored for compliance with a discard ban from a 10% audit of CCTV footage using AMR analysis software. Overall results show very low levels of discards, which are considered to be well within compliant levels and are comparable to results obtained in 2011 in which four quota stocks were trialled.

Stock	Discards as a percentage of total catch 2011	Discards as percentage of total catch 2012
North Sea cod	0.1%	0.1%
North Sea plaice	-	0.0%
VIIe sole	0.2%	0.1%
VIIde plaice	0.2%	0.6%
VII anglerfish	1.0%	0.7%
VII megrim	-	0.6%
Western hake (a)	-	1.9%

(a) Discards observed from a very low catch (weight) levels

The estimate of retained catch quantity using CCTV footage has been assessed across a range of methodologies and compared against control data gained from market sampling and at-sea observer sampling. Results have shown that a variety of methods of estimating catches can be used for auditing catches recorded in logbooks. Different methods of catch estimation vary in terms of accuracy and analysis time. Comparisons with control data have shown that catches can be estimated to within 5 to 20% depending on the fishery and the fish handling process.

An average analysis time of 3 hours per trip is considered to be a reasonable estimate for resource planning purposes.

The ability to monitor catches at each haul or day to this level of accuracy is positive, however more assessment is required before a performance scoring system could provide sufficient confidence to apply penalties for audit failure. The data produced by the system provides a far higher level of resolution than conventional surveillance methods; as such it is considered that an operational EM programme should focus on high level auditing while a more detailed system is developed.

Fish length-frequency data was obtained from CCTV footage using digital calliper software, which, although more time consuming, was found to correlate well to length-frequency data obtained by on-board observers depending on the species and fishery, provided sufficient numbers of fish can be measured. This suggests that there is scope for CCTV footage to be used as a data source for control purposes as well as other fisheries management requirements such as for stock assessment, although this will require full scientific evaluation.

It is therefore recommended that that there should be a standard baseline level of audit carried out for all EM monitored fisheries to check the integrity of EM data capture as well as to monitor and quantify discards. Comprehensive analysis on retained catch could also be carried out according to the requirements of individual fisheries and other data needs using a risk based approach.

A North Sea mixed fishery was examined in the context of gear selectivity and the potential impacts of a future landing obligation (discard ban) across a range of species. The data shows that managing mixed fisheries under a discard ban will require changes to current technical regulations such as those relating to catch compositions and minimum landing sizes. The findings also suggest that there would need to be a careful balance struck by fishermen, between levels of unmarketable catch and loss of target species revenue through enhanced selectivity or avoidance measures. There are also a number of mixed species fisheries, which would benefit from a scientific assessment to fully understand the implications of a discard ban in which there is a risk of early fishery closure because of exhaustion of quota for one or more species.

Further evidence of the reliability of the REM system has been gained as well as more insight into the potential technical and analysis infrastructure that would be required in an operational programme. System defects were successfully monitored in close to real time on one vessel, which was transmitting system health check data via satellite modem. An important part of an operational EM programme comprises the field service resource required to maintain, replace and upgrade systems on board vessels. For vessels that operate remotely, or from ports outside the UK, carrying spare equipment on board to minimise any delays that may be caused by the need to replace or repair EM equipment would be prudent. A fully operational scheme will need to address the risk of tampering with EM equipment which may require a performance-based penalty system in relation to data quality and integrity.

The trials have based additional quota incentive on the best available discard data, which is collected from a sample of vessels on a voluntary basis. The trial has shown that there may be gaps in the discard data which need to be assessed. For example, the discard data for VIIde plaice is taken predominantly from the offshore area where the rate of discarding may be considerably lower than for more inshore areas frequented by smaller vessels. It is therefore intended to focus on potentially high discard stocks in 2013 trials.

It is important to understand that EM implementation should not be regarded as a 'plug and play' system; the operational requirements and data needs need to be fully understood both by managers and operators which will vary from one fishery to another. As such applying EM should be carried out on a fishery by fishery basis rather than a big bang approach. It is considered that there is scope for greater collaboration between fisheries managers and scientists to ensure that EM data can be fully and efficiently used.

It is estimated that annual costs per vessel in a refined operational programme using Archipelago Marine Research Ltd monitoring equipment could be in the region of £8,000 to cover technical equipment, software maintenance and data analysis. The extent that EM should be used needs to be considered against the equivalent costs

of other means of full documentation of catches such as reference fleets or observers, as well as the risks to stock mortality and data capture across different fleets and fisheries. The potential benefits of full catch documentation should also be taken into account and to what extent cost saving can be achieved across current conventional monitoring and control measures.

Acknowledgements

The Marine Management Organisation would like to thank the masters, owners and crews of the participant vessels, whose cooperation has made these trials possible.

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The MMO is also grateful to Archipelago Marine Research Limited for their technical training, support and guidance.

Introduction

The UK Government believes that current high levels of discarding fish are wasteful and unsustainable. It therefore supports a progressive implementation of a discard ban or landing obligation, in which fishing mortality is fully accounted for. A fully documented catch quota system complemented by a landing obligation (where appropriate) is viewed as one of a range of innovative measures that can help deliver sustainable fisheries and minimise discards. Successful implementation of a landing obligation will require substantial changes to the current Common Fisheries Policy (CFP) regime which is widely held to be unfit for purpose, not least because of the regulatory discarding that it causes.

Changes to technical, control and quota regulations will be required in order to provide for a workable landing obligation. It is anticipated that in order to accommodate a transition to a landings obligation total allowable catches (TACs) are to be increased to reflect estimated discard mortality. There is also a need to simultaneously provide sufficient incentive and flexibility for fishers to avoid unwanted catches as far as possible, and to allow discarding (releases) of species with evidence of high survival rates.

During March 2013, informal trilogue discussions began between the European Parliament, the European Commission and the Council of Ministers, with the aim of reaching definitive agreement on CFP text including the provisions relating to a landing obligation from 2014.

Catch quota trials were carried out in 2011 involving 15 vessels. Fourteen of these were operating under a discard ban for one species (either North Sea cod or VIIe sole) and one vessel operated a discard ban for three stocks in western waters.

Trials in 2012 aimed to collect more data to evidence the impacts of implementing catch quota management for multiple stocks in UK mixed fisheries. The expansion of catch quota trials to a wider variety of fisheries had a key objective of assisting the UK Government's approach in the implementation of a landing obligation in collaboration with the fishing industry. More evidence is required as to how a catch quota system encourages changes in fishing behaviours such as improved uptake of more selective gears and spatial or temporal avoidance of unwanted catches. Low levels of unmarketable catches should demonstrate this.

The implications of so-called choke species also need to be examined further. It is evident from scientific discard data that certain species, particularly gadoids such as haddock and whiting and other demersal stocks such as plaice, have high discard rates in some fisheries. Such species may become choke species, where available quota under a catch-quota system would be exhausted long before quota limits for other target species are reached.

As part of a wider scope of work being carried out to assist with detailed fisheries reform implementation, this project examined some of the implications of mixed fishery management in the context of a landing obligation including the compatibility with current control and technical regulations.

Objectives of the 2012 scheme

1. To gain a greater understanding of the implications of a discard ban on multiple and single species for fishing masters and crews.
2. To undertake trials of catch quota management of an expanded range of stocks in the North Sea and Western Waters.
3. To undertake remote monitoring of high discard fisheries such as Celtic Sea haddock and North Sea plaice to evaluate the implications of a landing obligation for these stocks and the impact of associated selectivity and avoidance measures. (This objective was not achievable as no vessels in this category volunteered to take part.)
4. To consider the implications of a landing obligation and its compatibility with current technical and control regulations.
5. To monitor CCTV footage and sensor data from participant vessels at a sample rate of 10% to verify compliance with the discard prohibitions for catch quota stocks, correct reporting of area fished and catch estimates.
6. To assess the implications of monitoring CCTV footage for a range of species in mixed fisheries.
7. To carry out CCTV analysis to quantify the level of discards occurring for catch quota stocks.
8. To trial and improve various methods of quantifying retained catches of catch quota stocks from CCTV analysis as a means of auditing catch records.
9. To carry out seagoing observer trips to obtain quality control data on retained catches for the purpose of assessing confidence levels in CCTV analysis.
10. To trial satellite modem technology for the transmission of sensor data and remote monitoring system functionality.
11. To trial improved remote monitoring systems and software, which allow for increased numbers of cameras and sensors.

12. To trial remote monitoring equipment on a scallop dredging vessel to estimate and corroborate records of fish by-catches. (This objective has started in 2013 as the vessel was unavailable for much of 2012.)
13. To report on trials of remote monitoring equipment on small inshore vessels with unsophisticated catch sorting equipment. (This report is available separately on the MMO website.)

Methods

Allocation and management of catch quota

The additional quota for testing catch quota management was made available to participant vessels through their producer organisations at or below 75% of the expected discard rates set out in the application forms – see the example at Annex 2. The individual allocations were based on 2011 catches, which excluded any catch quota awarded in that year.

The expected discard rates were those published by the Scientific, Technical and Economic Committee (STECF) for Fisheries based on discards observed at sea.

In the case of VIIe sole, the additional quota awarded was based, as for 2011, on data from Project 50% (Centre for Environment, Fisheries and Aquaculture Science, 2009) from which it was acknowledged (STECF, 2010) that high levels of discards of sole above the minimum landing size were occurring because of quota restriction. The high levels of discards are thought to have arisen because catches could no longer be falsely reported to other stock areas as a result of restrictions imposed to prevent this.

Participant vessels were free to lease quota as typically their fishing opportunity is made up of a combination of leased fish, monthly catch limits set by their producer organisation and individual vessel allocation. It is essential for UK fishermen to have flexibility to lease or swap quota to maximise fishing opportunities from the mixed fisheries in which they operate, particularly as the quota linked to their fishing licence may be insufficient for historical reasons. This flexibility allows for adjustments to quota holdings to be made as far as possible in line with changing fishing plans and fluctuating stock abundance.

In order to ensure that additional quota provided under the scheme was used in proportion to the expected discard rate, the uptake of additional quota was monitored on a percentage basis for each landing.

For each landing a percentage, based on the discard rate for each stock, is deducted from the vessel catch quota allocation, with the remaining balance being deducted from the vessel's own allocation. Once the catch quota allocation was exhausted the vessels could only continue to fish if they had access to quota.

This ensured that the pool of catch quota vessels was operating in a responsible way whereby the overall catch is discard-free and overall mortality within the pool is reduced. In the case of North Sea cod there was insufficient catch quota available for all vessels to receive their full additional allocation. As a result quota shares among

the participant vessels were scaled back slightly to allow for maximum participation following agreement with applicants.

Participation

Table 1 summarises the number of vessels and the range of gear types and stocks subject to catch quota trials. There were 7 vessels from the South West and 12 vessels from the North Sea fleets that took part in the trials.

Table 1: Participating vessels by gear type and fishery

Gear type	Number of vessels	Species subject to catch quota terms
Otter trawl or pair trawl	9	Area IV North Sea cod
Otter trawl	1	Area IV North Sea Cod and North Sea plaice
Fixed gill net	2	Area IV North Sea cod
Beam trawl	1	Area VIIe Western Channel sole, VIIde Channel plaice, VII Western hake, VII anglerfish, VII megrim and VIIhjk sole*
Beam trawl	2	Area VIIe Western Channel sole, VIIde Channel plaice, VII Western hake, VII anglerfish, VII megrim
Beam trawl	1	Area VIIe Western Channel sole, VIIde Channel plaice, VII anglerfish, VII megrim
Beam trawl	3	Area VIIe sole

*Voluntary – no incentive quota associated with stock.

It is encouraging that more vessels overall opted to join the scheme in 2012 although there has been less than anticipated participation for high discard fisheries. A strong barrier to participation in high discard fisheries is the 30% cap on additional quota imposed by the Council regulations.

The 2012 catch quota pilots attracted interest from vessel owners engaged in the North Sea plaice and mixed-demersal beam trawl fishery and the Celtic Sea haddock and mixed-demersal otter trawl fishery. Both plaice and haddock in these two respective fisheries are known to be subject to high levels of discards and are therefore considered to be good examples of stocks that should be tested for management under a catch quota system. Owners who expressed an interest in participating in trials in these two fisheries felt that the incentive provided by an additional 30% of quota was much too low to mitigate the risk of having to stop fishing early in the year.

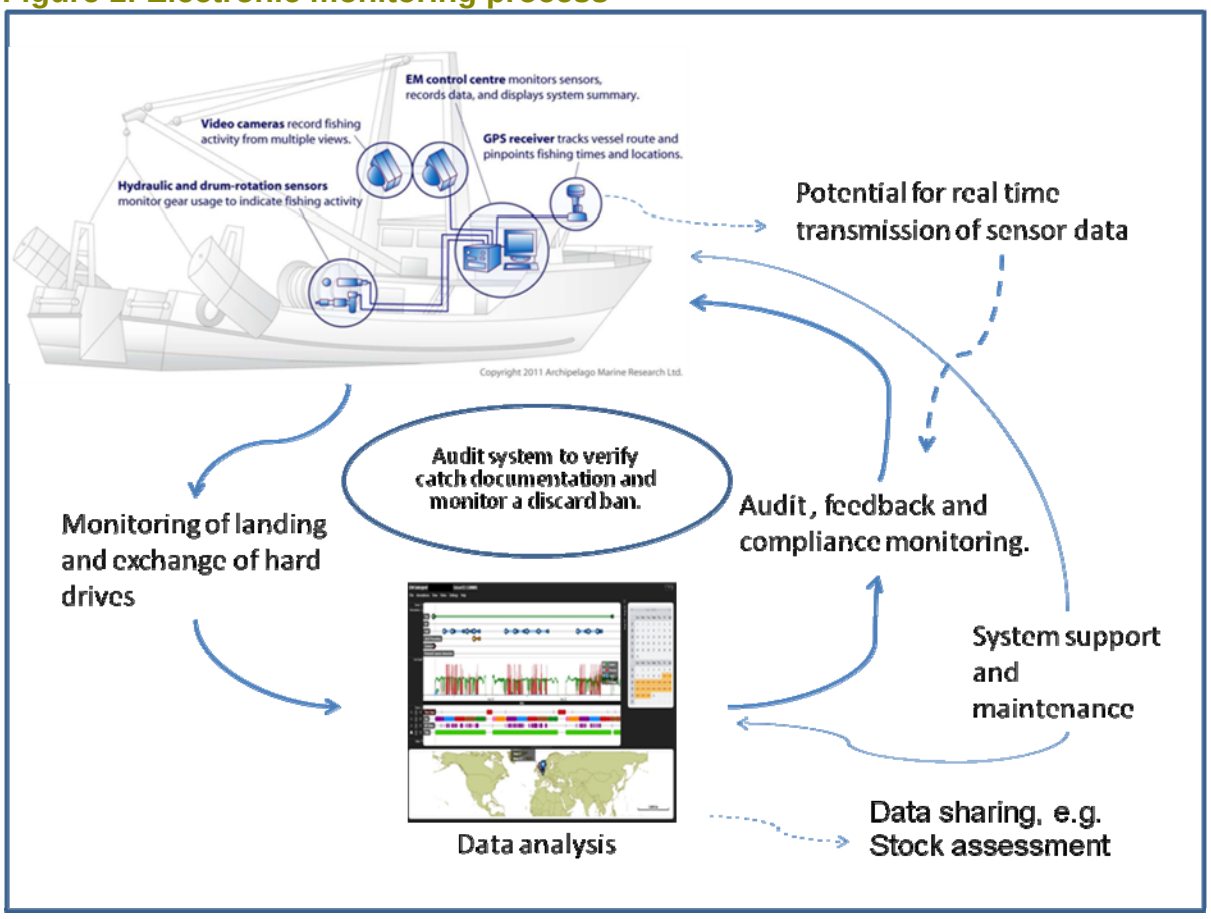
For example, the discard rate for English vessels catching haddock in International Council for the Exploration of the Sea (ICES) areas VIIb-k is assessed by STECF to be 57%. Therefore, capping the amount of quota that we can offer fishermen to 30% does not provide an incentive to them to participate because of the potential risk that a master will have to cease fishing before the end of the year, or incur costs to lease

in quota. Quota incentive should nevertheless take account of the impact on overall stock mortality and selectivity measures that can be put in place, particularly where discards relate to juvenile fish or unwanted catches.

Remote monitoring equipment and logistics

The 2012 scheme has continued to use the Archipelago Marine Research Ltd electronic monitoring (EM) system (Figure 1) with four or more cameras. A satellite modem compatible with the EM record system was also trialled to examine the potential for real time transmission of summarised sensor and system health check data.

Figure 1: Electronic monitoring process



MMO personnel were provided with technical training on EM systems by Archipelago Marine Research Ltd (AMR), which enabled in-house fault diagnosis and software maintenance as well as expertise in installation and repairs of ancillary equipment. Faulty EM units in or outside of warranty cover require replacement for repair by AMR in Canada.

Analysis of sensor data and CCTV footage was carried out using EM Interpret software on licence from AMR, technical support and training for this was also provided by AMR.

The setup cost per vessel consisted of approximately £10,000 per vessel including ancillary equipment, installation and software. EM systems were already installed on

board most participant vessels for trials carried out in 2011. The lifespan of the on-board system is thought to be a minimum of 3 years and carry a 1-year warranty. EM Interpret software was purchased from AMR at an approximate annual cost of £3,000 per licence for each workstation.

Additional costs included analysis screens and laptops, data storage devices and sufficient 500 GB to 1 TB hard drives in circulation service the trial fleet.

Control data

Three observer voyages were carried out in order to provide necessary control data to test the various methodologies used for estimating retained catch. Data was gathered using motion compensated weighing scales and the collection of on board length-frequency data. Further control data was also collected from auction centres.

Assessing the implications of a discard ban in mixed fisheries

The discard prohibition for catch quota species applies whether vessels are engaged in large mesh gadoid fisheries or in smaller mesh mixed demersal fisheries where juvenile cod by-catches are encountered. In reality some vessels participating on the scheme typically switch between these types of fisheries or nephrops fisheries. The implications of a discard ban for cod and other species are variable depending on the nature of the fishery.

As part of the trial we examined in more detail the catches of one vessel operating in a mixed fishery for plaice and lemon sole over 11 trips from May to September. The vessel was using twin-rig otter trawls fitted with 90 mm square mesh panels.

Codends in use in the lemon sole and plaice fishery were of 107 mm mesh size. One trip was conducted with MMO observers on board to sample catches and assess the relative catches between 120 and 107 mm codends.

Discard monitoring

The Council regulations require all catches of catch quota stocks to be retained, landed and counted against quota. Therefore, the basic compliance audit for CCTV analysis is to check for and quantify discards of catch quota stocks during the sorting and stowage operation.

10% of fishing operations are chosen at random for analysis. The random selection is made using a random number generation, which is applied to individual hauls or days depending on the fishery and gear type in use. Typically for trawlers, 10% of hauls are chosen, whereas for netters where hauling may continue through a daily cycle, 10% of individual days are selected. For each event selected for analysis the CCTV footage is viewed to monitor for any discarding of catch quota species.

CCTV analysts view footage for 10% of fish sorting operations and count the number of discard-prohibited fish that are not removed from the sorting conveyor and enter the discard chute.

In order to raise the number of discarded fish to weight, standard weight estimates are applied which are based on the weights of fish just below the minimum landing size or estimates where there is no prescribed minimum landing size as shown in

Table 2. This methodology is considered to give rise to an over-estimation of the weight of discarded fish as many discarded fish are well below these standard weights.

It is important to have a specified methodology for quantifying discards as a means of enforcing a discard ban. The Council regulations require vessels that discard to be removed from the scheme and have any additional incentive withdrawn. In practice some incidental discarding is considered to be inevitable but requires effective monitoring to ensure this is not significant. This raises a question about whether there should be an acceptable level of discards where an increase in selectivity is difficult to achieve or where there is a disproportionate cost for monitoring and handling of a small quantity of unwanted catch. For the purpose of the trial, no specific allowable limit was set but the levels detected did not warrant any action to be taken.

Table 2: Weight values used for estimating discards

Stock	Minimum landing Size (MLS) in cm	Conversion to kg using MLS – 1 cm	Estimated weight to use for discarded or undersize fish (kg)
Cod (Area IV)	35	0.374	0.35
Plaice (All areas)	27	0.189	0.17
Sole (All areas)	24	0.12	0.1
Hake (Area VII)	26	0.121	0.15
Megrim (Area VII)	25	0.092	0.08
Anglerfish (All areas)	None	Not applicable	Observer estimated. Small at 0.2 to 0.5 kg, medium at 0.5 to 1 kg

Disposal of undersized and unmarketable fish

Unmarketable fish was disposed of according to potential use as bait, or provided to fishmeal processors.

The majority of unmarketable catch was landed into Grimsby and Plymouth. Landings of unmarketable catch to Grimsby consisted of undersized cod from mixed demersal fisheries, which could on occasion amount to 400 to 500 kg which was disposed of to the local fishmeal processor. Smaller quantities of cod were provided for use as bait.

Landings of unmarketable catches to Plymouth were mainly comprised of small and damaged flatfish species, predominantly plaice and megrim. These species were landed in smaller quantities of around 50 kg a trip. All beam trawler landings were sold at auction, which held the unmarketable catch in chilled storage separate from the marketable catch before making it available for use as bait.

The unmarketable catches were documented by the auction by adding the quantity onto the vessel's sales note at zero value. The fishmeal processor provided documentation on the amount of fish received. This documentation was used by the MMO for quota uptake.

EM sensor and CCTV audit

Audit stages

The data retrieved from hard drives was subject to three levels of audit.

Stage 1 – Data integrity and quality. The hard drive data is checked for any gaps for the relevant period and the CCTV image quality is checked to ensure cameras are operating correctly and have been maintained to provide good image quality. The data from gear hydraulics and winch rotation sensors are annotated to allow for subsequent analysis of CCTV footage. This stage also allows for high-level auditing to check that the correct area of fishing has been recorded in the logbook and for fishing operations in relation to area restrictions.

Stage 2 – CCTV footage from a random selection of fishing operations is analysed to estimate the level, if any, of discards for relevant discard prohibited stocks. This normally entails observations of discards where fish have not been retrieved during the sorting operation and are returned to the sea, often via a conveyor to a discard chute. The total estimated discards for each trip are calculated by multiplying the observed discards by a raising factor determined by the sample rate, which is normally 10% of fishing operations. For this purpose standard weights are used for each species and may give rise to an over-estimate of actual discards.

Stage 3 – CCTV footage is analysed to estimate retained catches for each fishing operation or for consecutive fishing operations for the purpose of checking the logbook for accuracy. There are a number of methods for achieving this, which are examined in more detail in the retained catch section of this report. This process may involve a simple count of fish containers, obtaining weights from length-frequency measurements or monitoring for discards beyond the point of sorting and stowage.

Trials carried out in 2011 demonstrated that the ability to quantify catches from CCTV footage depended on the nature of the fishery and the volume and method of handling and sorting catches.

One of the key aims of the 2012 trials was to develop, where possible, effective audit methods that would provide sufficient confidence in quantifying retained catches according to a specific method. It was assumed for the purpose of this trial that the term 'fully documented fishery' includes the ability to audit catch records.

Moreover, an important consideration, other than to test the efficacy of auditing catch records from EM data and CCTV footage, is to assess the quality of data that can be gained for other purposes such as scientific stock assessment and trigger levels for real time closure areas. Trials were therefore carried out with digital on screen calliper software to obtain fish length data.

Audit methods for retained catch

The methods of auditing retained catch records are summarised below.

1. Full retention monitoring

10% of fishing operations are monitored for discards as detailed above and to check that all catches are stowed. Further monitoring can then be undertaken to ensure catches are not removed from the fish room until the point of landing. This is likely to be more pertinent to low volume catches which may be susceptible to discarding after the point of stowage for commercial or quota restriction reasons. For this purpose cameras can be mounted to view the deck and fish room hatch. Where multi-annual plans require certain stocks to be stowed in separate compartments, such as ICES VIIe sole, a camera can be placed in the fish room to record the cumulative catch over a trip.

2. Assessment of bulk catches
Where catches are taken on board in bulk and are processed without separating into containers at the point of sorting, it may not always possible to make reliable catch estimates. This includes vessels on which catch is sent directly into the fish room by conveyor or where individual fish are stowed in pounds rather than boxes. In such cases it may be preferable to simply monitor full catch retention but it may also be possible to gain estimates from the volume passing along a conveyor.

3. Volumetric assessment of multiple or part containers
Where catches are separated into containers by species at the point of sorting, a quantitative estimate can be made based on known weights of baskets or boxes. In some cases catches are taken in small quantities which only part fill a box or basket from one fishing operation. In such cases it may be preferable to quantify cumulative catches over consecutive hauls over a 24-hour period to compare to 24-hour catch records.

4. Verification of weight displayed on weighing systems
Two sets of motion compensated scales were tested to allow crew to weigh catches and improve on-board catch estimates. The LED readout from the scales could also be viewed on CCTV footage to allow 'remote' weighing of catches.

5. Use of digital calliper software to obtain catch length data
This can be used for comparison to landed catch length-frequency (either through sampling or market grading data), or to obtain weight estimates using length to weight conversion factors. The method relies on sufficient numbers of fish being measured from CCTV footage using digital calliper software.

Results and discussion

Audit levels

During the trial the majority of analysis has involved all three stages. The time taken for stage-3 analysis is highly variable depending on the method used. It is envisaged that an operational program would require full coverage for stage 1 and 2. The stage-3 analysis could then be adapted to the fishery and carried out on a risk-based approach.

Table 3 shows the level of audit of EM data and CCTV footage across the range of vessels. The target audit level has been set at 10% of fishing operations. Where vessels have operated in more than one stock area the trip has been split for audit purposes, hence the number of trips outlined in the table is higher than the actual

number of trips carried out. Any trips in areas that were outside the scope of the catch quota stocks were not analysed, other than to verify data integrity and reported area of catch.

Table 3: Percentage of hauls analysed against 10% target

Gear type	Number of trips	Number of hauls fished	Number of hauls sampled	Percentage of hauls analysed
Beam trawl (1 species)	114	7,015	572	8
Beam trawl (3 species)	6	207	59	29
Beam trawl (4 species)	51	2,323	220	9
Beam trawl (5+ species)	86	3,327	280	8
Gill net	28	154	25	16
Otter trawl	141	1,674	196	12
Pair trawl	30	285	37	13
Totals/average	456	14,985	1,389	9.3

The overall analysis rate was 9.3% of all fishing operations and included analysis of retained catch using a range of methods.

Table 4 shows the average time taken for full stage-3 analysis across the different gear types and in relation to the number of discard-prohibited species.

A number of factors influence the time taken to audit a trip apart from the method and sample size. These include trip length, catch sorting time, number of hauls and number of species being examined. For example the gill net fishing operation (haul) is typically an 18 to 24-hour activity, so a longer period is required to analyse one operation. In this case the analysis time for one trip is less than for one hauling operation as one day in 10 is analysed which can span two trips or more.

Table 4: Analysis rates carried out in 2012 and average analysis time

Gear type	Number of trips	Number of hauls sampled	Total analysis time (hours)	Average analysis time per haul (hours)	Average analysis time per trip (hours)
Beam trawl	114	572	302.3	0.5	2.7

Gear type	Number of trips	Number of hauls sampled	Total analysis time (hours)	Average analysis time per haul (hours)	Average analysis time per trip (hours)
Beam trawl (3 species)*	6	59	47.0	0.8	7.8
Beam trawl (4 species)	51	220	121.4	0.6	2.4
Beam trawl (5+ species)	86	280	246.7	0.9	2.9
Gillnet	28	25	135.5	5.4	4.8**
Otter trawl	141	196	502.3	2.6	3.6
Pair trawl	30	37	122.5	3.3	4.1
Totals/average	430	1,389	1,477.7	1.1	3.4

* These trips were subject to more than one retained catch estimation methods hence the lengthy analysis time for full trips.

** Full trip analysis takes less time than single haul analysis because a fishing operation is one full day's fishing and one day in ten is analysed which may span two trips.

As a result of the mix of audit methods tested during the trial the time taken to carry out analysis in table 5 should be regarded as an indication for full stage-3 audits. It is not considered appropriate to draw conclusions from the relative variation between gear types and number of species because of the large variation in methods used.

Monitoring for discards does not necessarily take any longer for multiple species than for single species as more than one species can be monitored simultaneously. Retained catch estimation times are not exclusively influenced by the number of species, but also by the type of vessel and fishery. The average stage-3 analysis time is 3.5 hours at a 10% sample rate (excluding the extended time taken to analyse the beam trawl trips with three species which were subject to repeated audits to trial a number of methods).

Table 5: Analysis time across three stages of data integrity, discard monitoring and catch estimation

Gear type	Total analysis time (hours)	Average analysis time per trip (hours) Stage 1	Average analysis time per trip (hours) Stage 2	Average analysis time per trip (hours) Stage 3	Total analysis time per trip (hours) Stages 1, 2, and 3

Gear type	Total analysis time (hours)	Average analysis time per trip (hours) Stage 1	Average analysis time per trip (hours) Stage 2	Average analysis time per trip (hours) Stage 3	Total analysis time per trip (hours) Stages 1, 2, and 3
Beam trawl	302.3	0.6	1.25	0.85	2.7
Beam trawl (3 species)	47.0	0.7	3.23	3.87	7.8
Beam trawl (4 species)	121.4	0.5	1.32	0.58	2.4
Beam trawl (5+ species)	246.7	0.5	1.08	1.32	2.9
Gillnet	135.5	0.1	2.7	2	4.8
Otter trawl	502.3	0.1	1.4	2.1	3.6
Pair trawl	122.5	0.1	1.2	2.8	4.1
Total	1,477.7				

A number of trips were not analysed for the reasons provided in Table 6, or where more detailed catch estimation methods precluded the ability to meet the 10% audit requirement because of the additional time required. In most cases this was because the vessel was operating outside relevant stock areas or engaged in non-fishing activities. Data for 9 trips was lost because of a failure of backup data after the original hard drives had been deleted. The analysis time is attributable to verifying that fishing activity did not take place or that the vessel was fishing outside relevant stock areas.

Table 6: Breakdown of data not analysed and reasons

Reasons for exclusion from analysis	Number of trips	Number of hauls fished	Total analysis time (hours)
EM system failure	7	139	0
Data lost from backup	9	184	4.5
Fishing in non-catch quota area	8	94	1
Research trips	26	0	2.5
Guard work	52	0	10
Transiting trips	34	0	2

Reasons for exclusion from analysis	Number of trips	Number of hauls fished	Total analysis time (hours)
Vessel breakdown	1	0	0
Totals	136	417	20

Observed discards

Table 7 provides the data on total discards of catch quota stocks raised from sample level to a percentage of total catch. The results show minimal discards for most stocks that amounts to 0.3% overall. Participants were advised that where discards were observed quota adjustments may be made to ensure the total fishing mortality is accounted for, however the very low discard rates did not require this course of action.

Table 7: Observed discards of catch quota species raised to total estimated discards

Gear group	ICES area	Species	Observed discards from CCTV analysis (kg)	Total discards raised from sample (kg)	Total catch (kg)	Percentage discarded
Beam trawl	VIIe	Sole	11.6	105.6	75,483	0.1
Beam trawl	VII	Anglerfish	92.6	980.8	147,741	0.7
Beam trawl	VII	Hake	0.5	5.1	301	1.7
Beam trawl	VII	Megrim	7.5	83.5	14,048	0.6
Beam trawl	VIIde	Plaice	32.9	303.0	49,319	0.6
Beam trawl	VIIhjk	Sole	0.0	0.0	233	0.0
Gillnet	IV	Cod	94.3	580.6	184,252	0.3
Otter trawl	IV	Cod	123.9	1,058.4	586,097	0.2
Otter trawl	IV	Plaice	0.0	0.0	8,971	0.0
Pair trawl	IV	Cod	6.2	47.4	113,550	0.0

Gear group	ICES area	Species	Observed discards from CCTV analysis (kg)	Total discards raised from sample (kg)	Total catch (kg)	Percentage discarded
Totals			369.5	3,164.4	1,179,995	0.3

Area VII hake shows a discard rate of 1.7% but this amounted to only 5 kg of fish from a total catch of 301 kg.

Anglerfish and megrim discards were estimated at just over 0.5% and consisted of very small specimens that may have gone unobserved by crew sorting from the conveyor.

Discards of gill net cod were 0.3% resulting from deliberate discards of fish that had parasitic infestation. The degree of infestation can be exacerbated when nets are subject to longer than intended soak times. Extended soak times may be a result of force majeure situations, such as engineering defects where a vessel is unable to attend nets. In the interests of preserving the retained catch in good condition discarding of infested catch has been allowed provided that such events are documented and the condition of the fish can be verified from CCTV footage.

Observer data from one voyage recorded the quantity of infested catch at less than 1% of total catch and reported the catch to be severely emaciated. There are likely to be other gill net fisheries where levels of predator related damage and decay may occur, such as in turbot and brill fisheries which typically have longer soak times than for gadoid fisheries.

Undersized and unmarketable catch

Across all fisheries and gear types the quantities of unmarketable fish (landed catch consisting of undersized and damaged fish) have been at levels of between 0 and 7.4% as shown in Table 8. The proportion of unmarketable catch that is undersized varies between gear types and fisheries.

Undersized and unmarketable catches were disposed of to fishmeal outlets or for use as bait. Documentation was provided for the unmarketable catch to allow for this component to be entered onto the fishing activity database for quota uptake purposes.

Table 8: Percentages of undersized and unmarketable catches with observed discard values and official discard rates

Gear group	ICES area	Species	Undersize and damaged weight (kg)	Total catch (kg)	Percentage undersize and damaged catch	Percentage including discards	UK discard rate (2011 data)
Beam trawl	VIIe	Sole	97.8	75,483	0.1	0.2	5.9
Beam trawl	VII	Anglerfish	204.6	147,741	0.1	0.8	11.4
Beam trawl	VII	Hake	18.5	301	6.1	7.8	18.2
Beam trawl	VII	Megrim	1,033.2	14,048	7.4	8.0	10.6
Beam trawl	VIIde	Plaice	1,121.3	49,319	2.3	2.9	4.9
Beam trawl	VIIhjk	Sole	0.1	233	0.0	0.0	N/A
Gillnet	IV	Cod	859.5	184,252	0.5	0.8	0.0
Otter trawl (100 to 119 mm)	IV	Cod	3,100.9	51,321	6	6.1	18.5 (100 mm+)
Otter trawl (120 mm+)	IV	Cod	2,913.8	537,741	0.5	0.7	18.5 (100 mm+)
Otter trawl (100 to 119 mm)	IV	Plaice	0.0	7,983	0.0	0.0	8.2 (100 mm+)
Otter trawl (120 mm+)	IV	Plaice	0.0	1,044	0.0	0.0	8.2 (100 mm+)
Pair trawl	IV	Cod	300.0	113,550	0.3	0.3	18.5 (100 mm+)
Total	All	All	9,649.7	1,179,995	0.8	0.9	

Overall a little over 10 tonnes of fish were either discarded or unmarketable because of condition or size representing less than 1% of the total catch. 60% of this comprised of cod from mixed demersal North Sea fisheries. However, most of the North Sea effort by participant vessels was engaged in large mesh fisheries for gadoid stocks, which results in the low overall percentage of unmarketable cod at 0.8%. 10% of the total unmarketable catch comprised undersized and damaged plaice catches from the beam trawl fishery.

North Sea cod

The targeted cod gill net fishery is highly selective with no undersized fish being caught. The unmarketable component is largely made up of mature fish that have been suspended in the net for too long and/or suffered from predation. It should be noted that during the trial, gill net caught cod in poor but marketable condition was sold at a low price. This fish would normally be discarded. The fish in this category has not been quantified but evidence from one observer trip suggests it may be a high as 4% of total catch.

Up to around 35% of cod caught in North Sea mixed trawl fisheries with less than 120mm codend mesh size, were undersized on some trips, although the overall catch percentage was 6%. Cod catches in mixed demersal fisheries are examined in more detail in the relevant section below. By contrast the overall catch of undersized cod catch from 120 mm+ fisheries was 0.5%. In the context of catch quota management this highlights the need for greater flexibility of the technical measures, which currently regulates what can be landed without sufficient regard to what is caught in the process.

South West beam trawl fishery

Beam trawl caught sole have few if any undersized fish in the catch with the unmarketable component being a result of damage sustained in the gear.

Unmarketable megrim and plaice in beam trawl catches tend to be a variable mix of undersized and damaged fish with the undersized component resulting from the gear being less selective for these species than for sole.

Anglerfish does not have a minimum landing size and its shape makes gear selectivity inefficient. Anglerfish unmarketable catch is therefore made up of damaged fish of various sizes or of small fish, which are not currently considered to be marketable.

Hake shows a high proportion of unmarketable catch from the beam trawl fishery, which reflects the delicate nature of this species. Most of the unmarketable catch was above the minimum landing size although it was caught in very small quantities amounting to only 300 kg for the full year.

Figure 2 shows the relative length-frequency curves of catches from observed trips for the key species analysed. No sole or megrim below the minimum size was caught – unmarketable catches for these species were a result of poor fish condition rather than size. This suggests that small fish are being avoided either spatially and/or a result of gear selectivity.

Plaice catches show a small level of catch below the minimum size but there is still an element of fish in poor condition making up the total unmarketable component.

Anglerfish catches show a wide distribution of size down to about 16 cm, which demonstrates the lack of selectivity for larger specimens of this species. Most of the unmarketable catch resulted from actual discards (0.7% of total catch) rather than poor condition. It is thought that this reflects the habitual discarding of small anglerfish which have a low market value and which crews consider to have high survival rates although it is not known what scientific data there is to support this view.

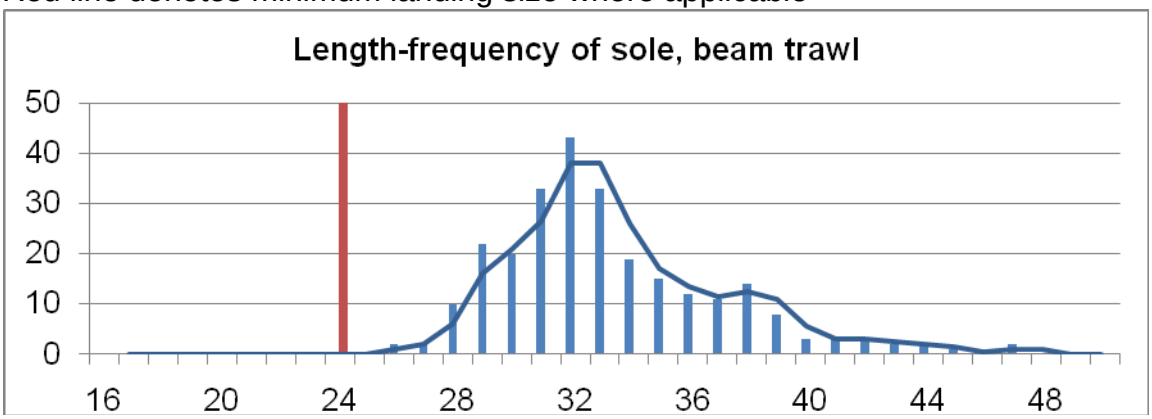
North Sea cod length frequencies were taken from a mixed demersal fishery. During part of this voyage one codend of the twin trawl was fitted with a 120 mm codend with the other at the normal 107 mm. It can be seen that both trawls caught a significant amount of cod below the minimum size although the smaller mesh caught roughly double that of the larger.

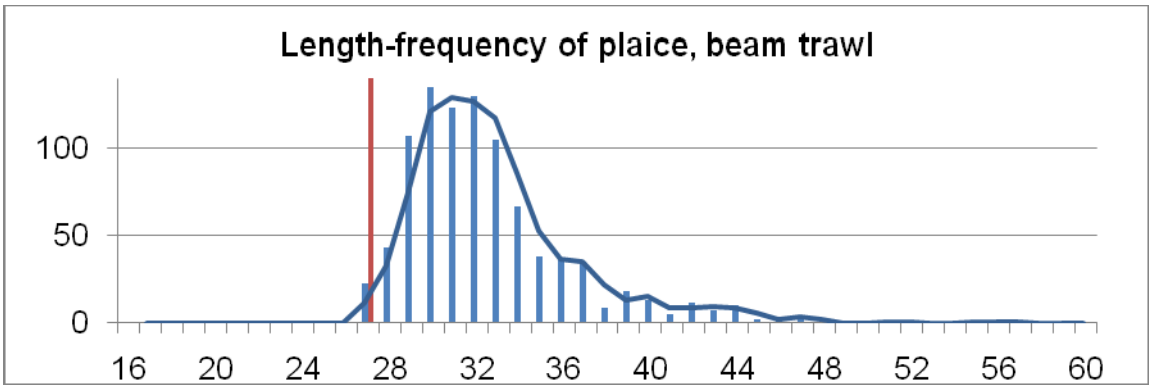
Length-frequencies were not collected from the targeted trawl cod fisheries, which generally take place in more northern waters, but the very low catch of undersized cod from these fisheries demonstrates effective selectivity and/or spatial avoidance of juvenile cod.

The length frequency data from the North Sea gill net fishery shows that the entire catch consists of mature fish of 50 cm or more. The unmarketable catch from this fishery results solely from poor fish condition.

Overall the vessels on the trial largely avoided juvenile fish capture and did not have to use a significant amount of quota on unmarketable catches. The implications for these fisheries operating under a discard ban are considered in more detail in the sections on mixed fisheries.

Figure 2: Length-frequency of key stocks from observer data
Red line denotes minimum landing size where applicable




Length-frequency of plaice, beam trawl
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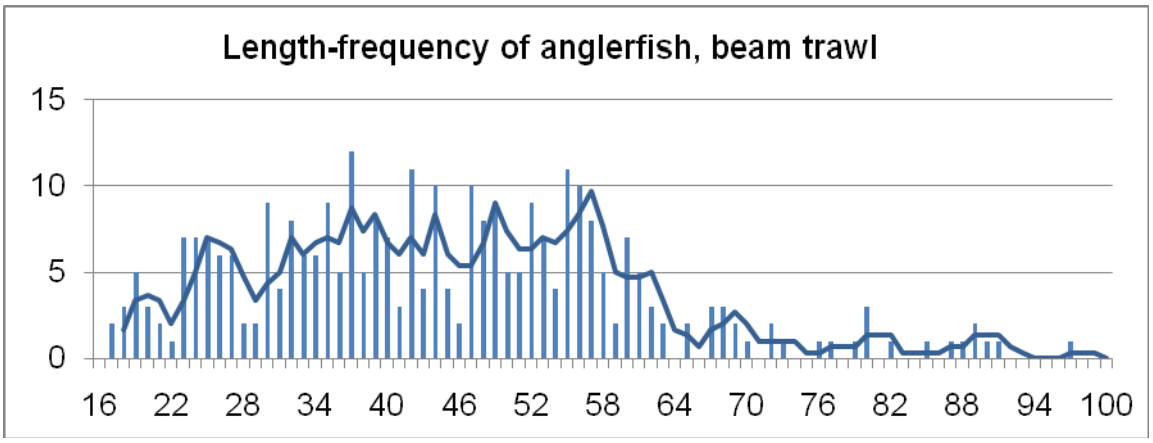
50
0
16 20 24 28 32 36 40 44 48 52 56 60


Length-frequency of anglerfish, beam trawl
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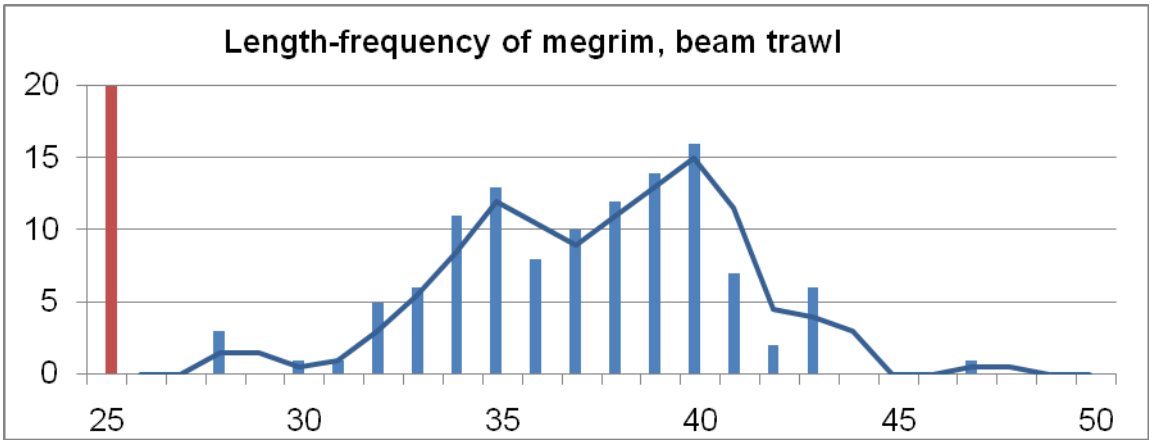
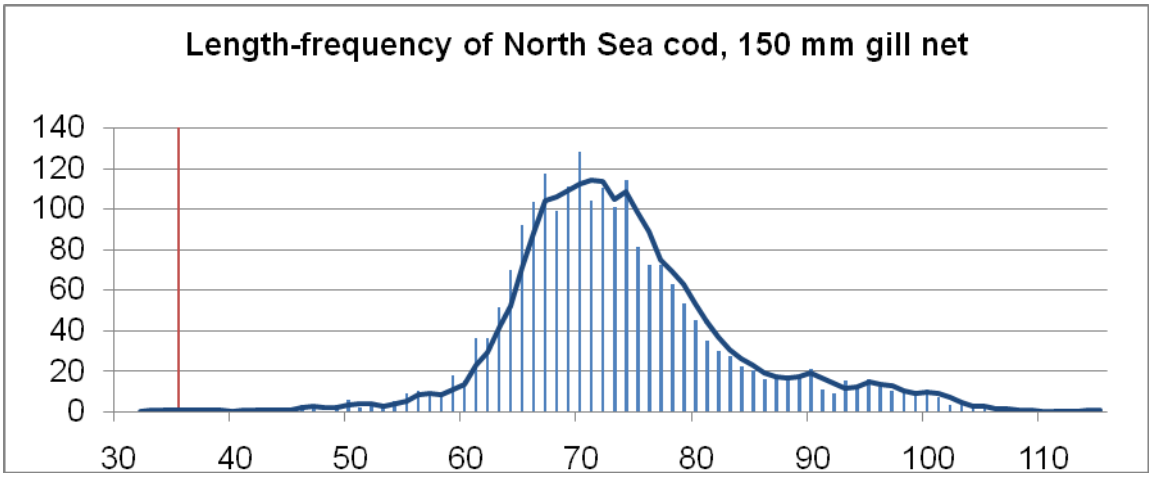
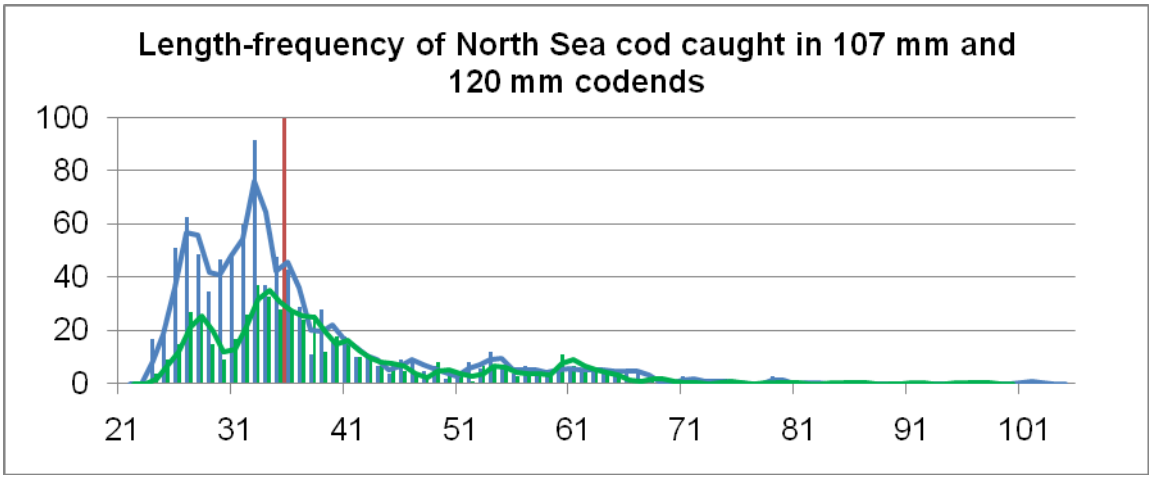
10
5
0
16 22 28 34 40 46 52 58 64 70 76 82 88 94 100


Length-frequency of megrim, beam trawl
20
15
10
5
0
25 30 35 40 45 50


Length-frequency of North Sea cod, 150 mm gill net
140
120
100
80
60
40
20
0
30 40 50 60 70 80 90 100 110



Retained catch audit

Trials have shown that the ability to quantify the retained catch from CCTV footage is dependent on a number of factors related to the type of fishery and may require a degree of adjustment to the way the catch is handled. The resource required for estimating retained catch is also an important consideration as this is potentially a significant part of the operational cost of an electronic monitoring programme.

Stage-2 monitoring determines the level of prohibited discarding during the fish sorting and processing phase from a random sample of fishing operations. Stage-3 monitoring can then be carried out to audit the accuracy of the catch record submitted by the master either on each haul or for a full day. These methods are described and assessed below.

Full retention monitoring

Once prohibited discards have been assessed the footage can be used simply to verify that the catch has been stowed in the fish room and not removed until the scheduled landing. This can be achieved by viewing random sections of footage prior to landing.

An alternative method was tested that involved a camera viewing a fish room pound in which sole was stowed as shown in Figure 3. Stock recovery regulations require sole to be stowed in an area of the fish room separate from other species and therefore lend itself to this type of monitoring.

The analyst can monitor the number of stowed boxes at any point in the trip and compare this to the cumulative logbook estimate. The footage can also be checked to ensure the boxes are only removed at the scheduled point of landing.

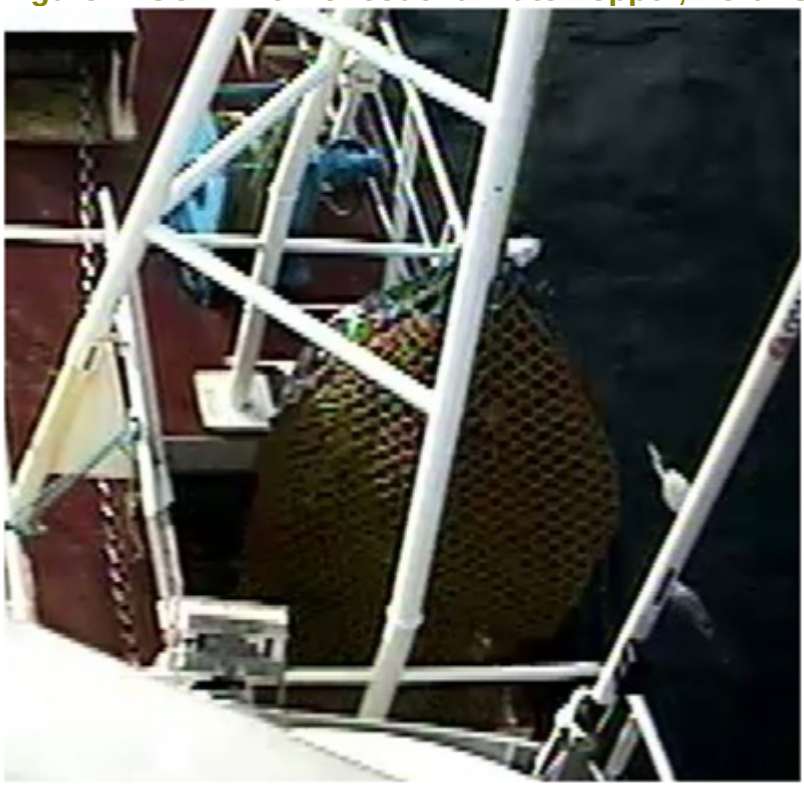
Figure 3: Fish room camera view of sole stowage area

Assessment of bulk catches

Assessing catch as it passed along a conveyor to the fish room did not prove to be a method worth pursuing, as there was too much variation in the volume depending on relative catch rate and speed of the sorting operation.

An alternative bulk catch estimate involves a visual assessment of the catch coming on board as shown in Figure 4.

Figure 4: CCTV view of codend lift to hopper, North Sea otter trawler



In relatively clean single species fisheries, such as for saithe, trials in 2011 involved estimates of bulk catches by estimating the total weight of each haul from the size of the codend or aggregate estimates from multiple codend lifts (where the volume of fish prevents stowage of all fish in one lift). In 2012, two full trips were analysed using this method and compared against the total catch in live weight. The method was also tested against the master's estimates on a haul-by-haul basis. The results for haul-by-haul estimates were not compared to control data and there was considerable variance between master and analyst estimates as might be expected from a crude method.

The results of the total trip analysis are shown in figures 5 and 6 below. There is a reasonable correlation (within 20%) between the analyst's estimate and total catch and more variation apparent at a haul-by-haul level. This method is quick in terms CCTV footage review and may be appropriate in some clean fisheries where the bulk of the catch consists of one species. Other trials have tested the use of load cells to weigh total codend weight to within 3% but with some reliability problems (Seafish, 2009).

Figure 5: Comparison of estimates of bulk catch by analyst with catch record for total trips

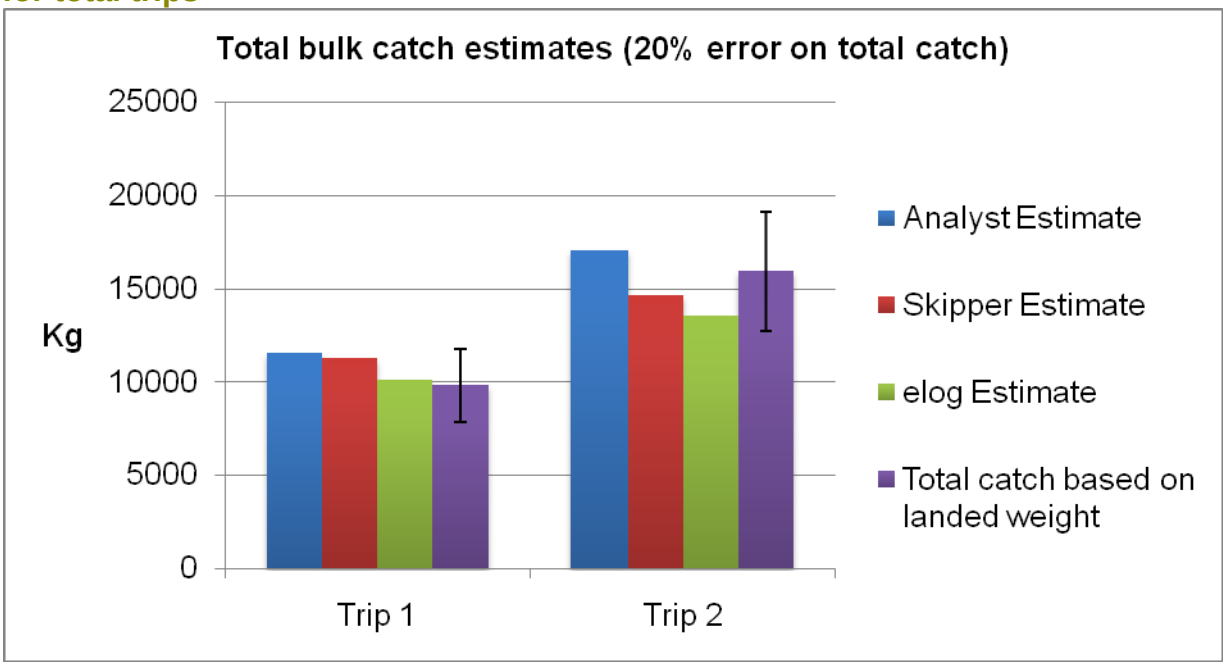
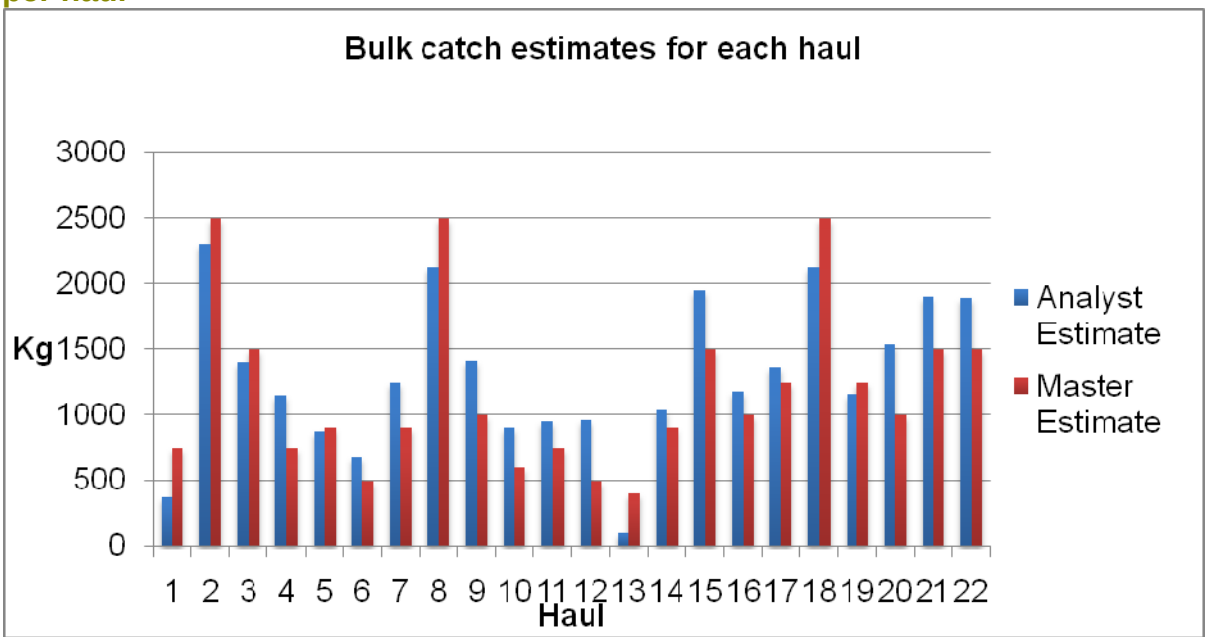


Figure 6: Comparison of estimates of bulk catch by analyst with catch record per haul



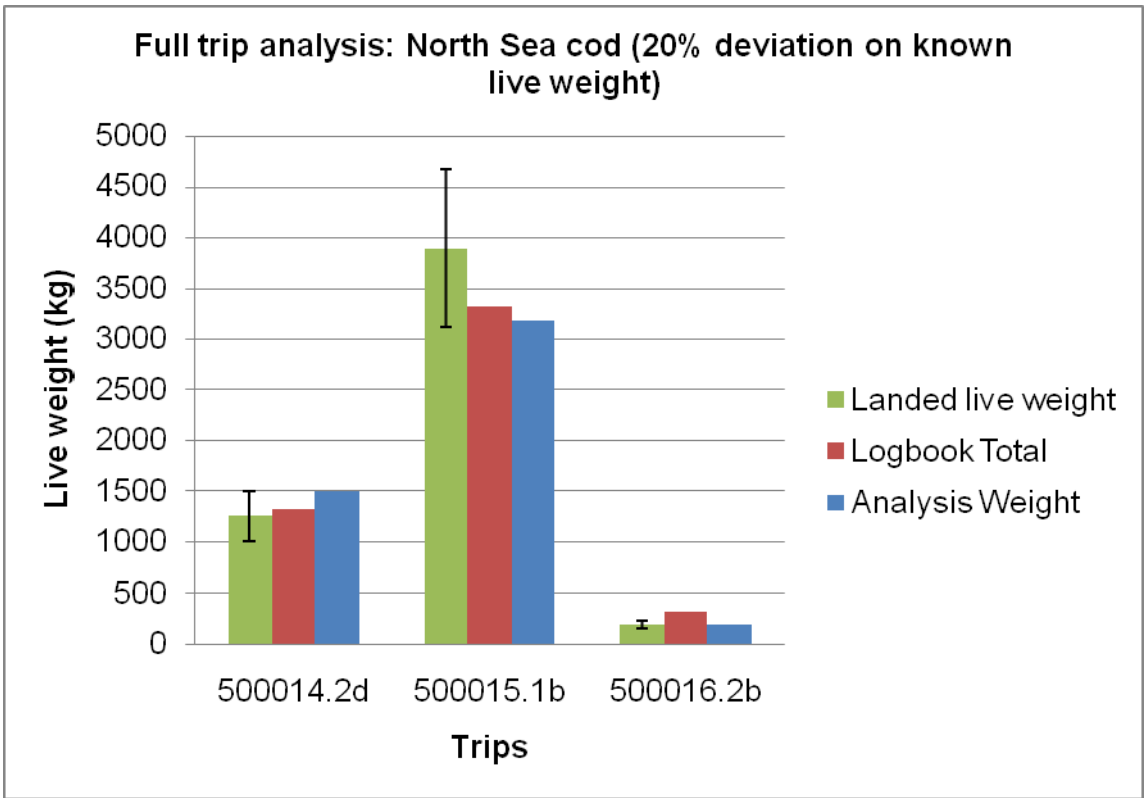
Volumetric assessment of multiple or part containers

Counts of baskets of fish lowered into the fish room (Figure 7) during each fish processing event were relatively quick to achieve through CCTV analysis, typically taking around 15 minutes depending on the volume of fish caught.

Figure 7: CCTV footage stills of baskets of cod lowered to the fish room

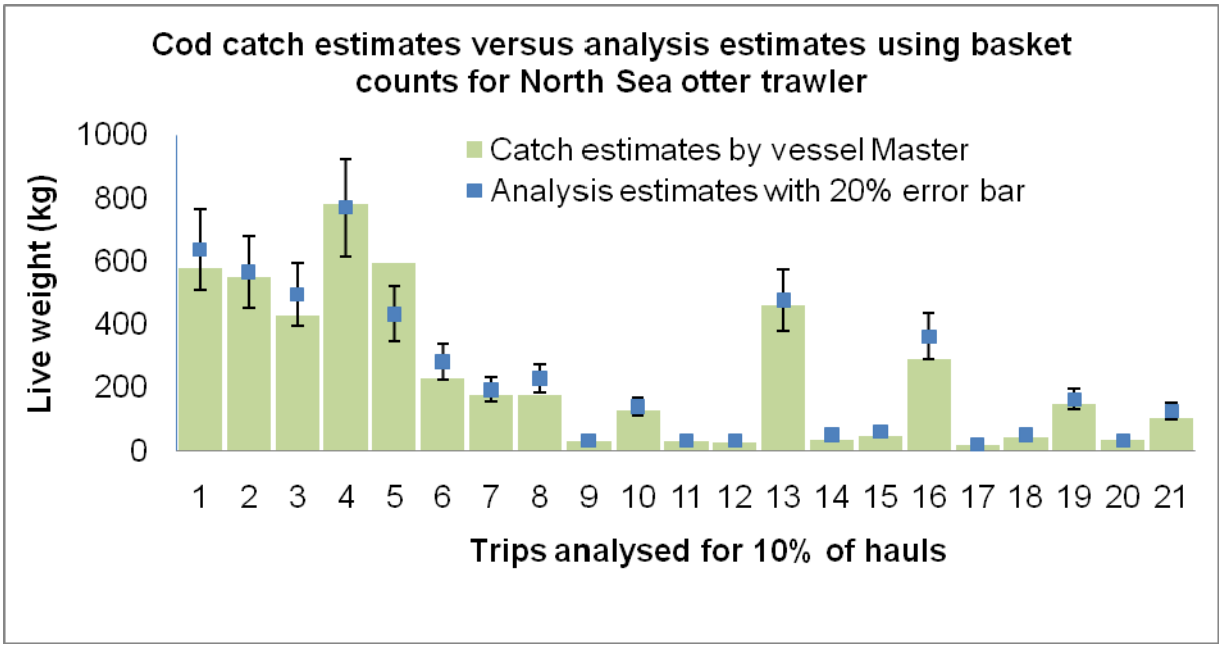
Analyses of footage from three full trips were carried out to ascertain the accuracy of estimates against the landed weight as reported on the sales note converted back to live weight. Results shown in Figure 8 show that analysis estimates are within 20% of the landed weights.

Figure 8: Comparisons of cod catch analysis estimates over full trips using basket counts



Analysis was undertaken on 10% of hauls for a North Sea otter trawler across 21 trips using this analysis method. The comparison between analysis and master estimates are shown in Figure 9.

Figure 9: Comparison of cod catch estimates on catch records with analysis estimates



Verification of weight displayed on weighing systems

A straightforward method that relies on the crew weighing catches and requires a clear camera view of the weight readout from the scales. The results are included in the comparisons of different methodologies below.

Use of digital calliper software to obtain catch length data

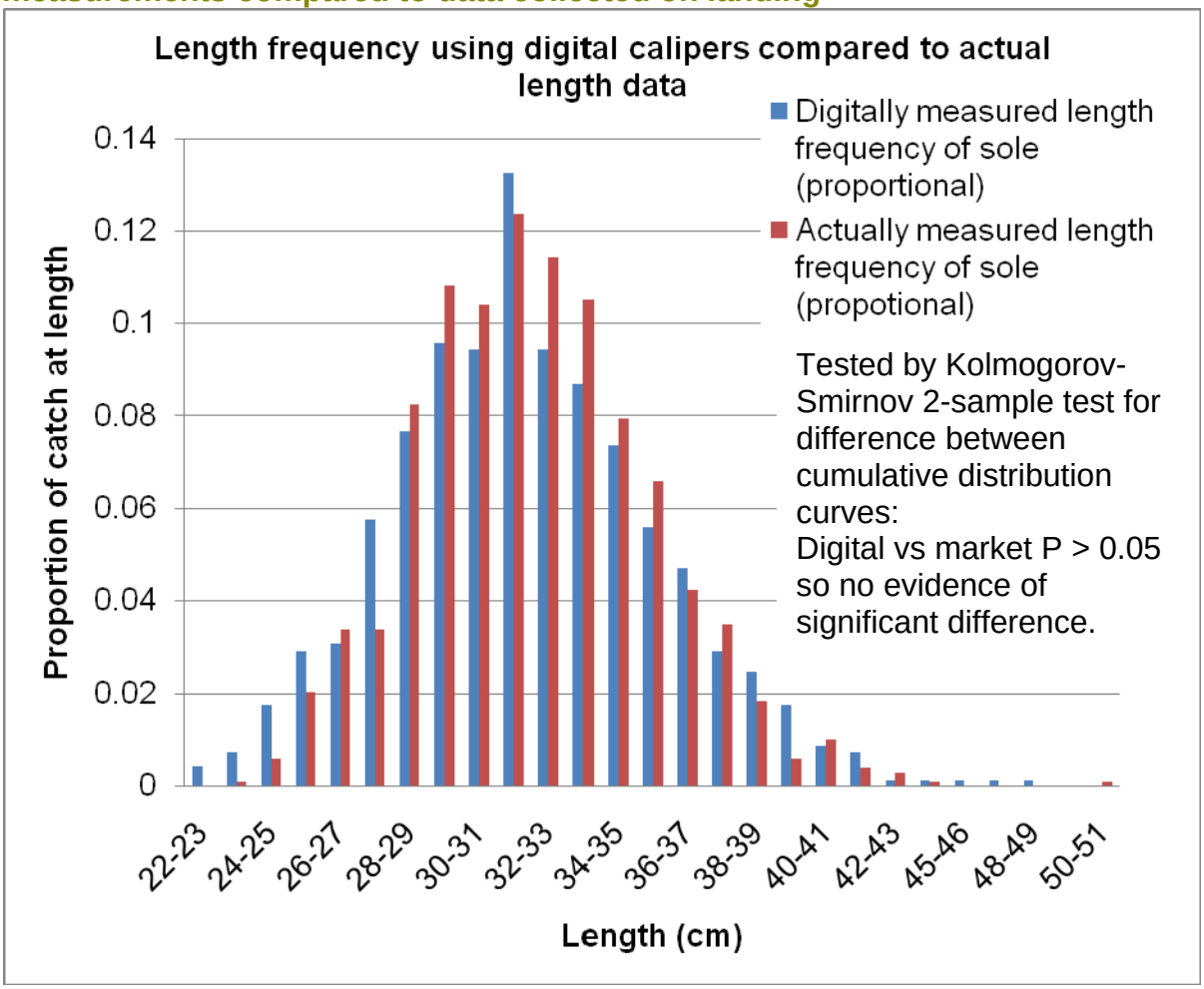
Catch length-frequency data can be used in a number of ways to make comparisons between observed catch from CCTV to catch on landing. The camera setup is critical in being able to make adequate observations and generally requires a camera looking directly down on the fish to avoid errors through image distortion. Two cameras were used to cover the full length of the sorting. For the purpose of the trial standard wide angle lenses were used which have the effect of distorting the image and creating a fisheye effect.

A crude method of calibrating the different areas of the image was used for the purpose of ascertaining the possibilities using this method. Figure 10 below shows the sorting conveyor of a beam trawler split into 6 areas which were used to calibrate digital callipers according to the known width of the sorting conveyor.

Figure 10: Screen shot showing plaice on conveyor with calibration areas superimposed

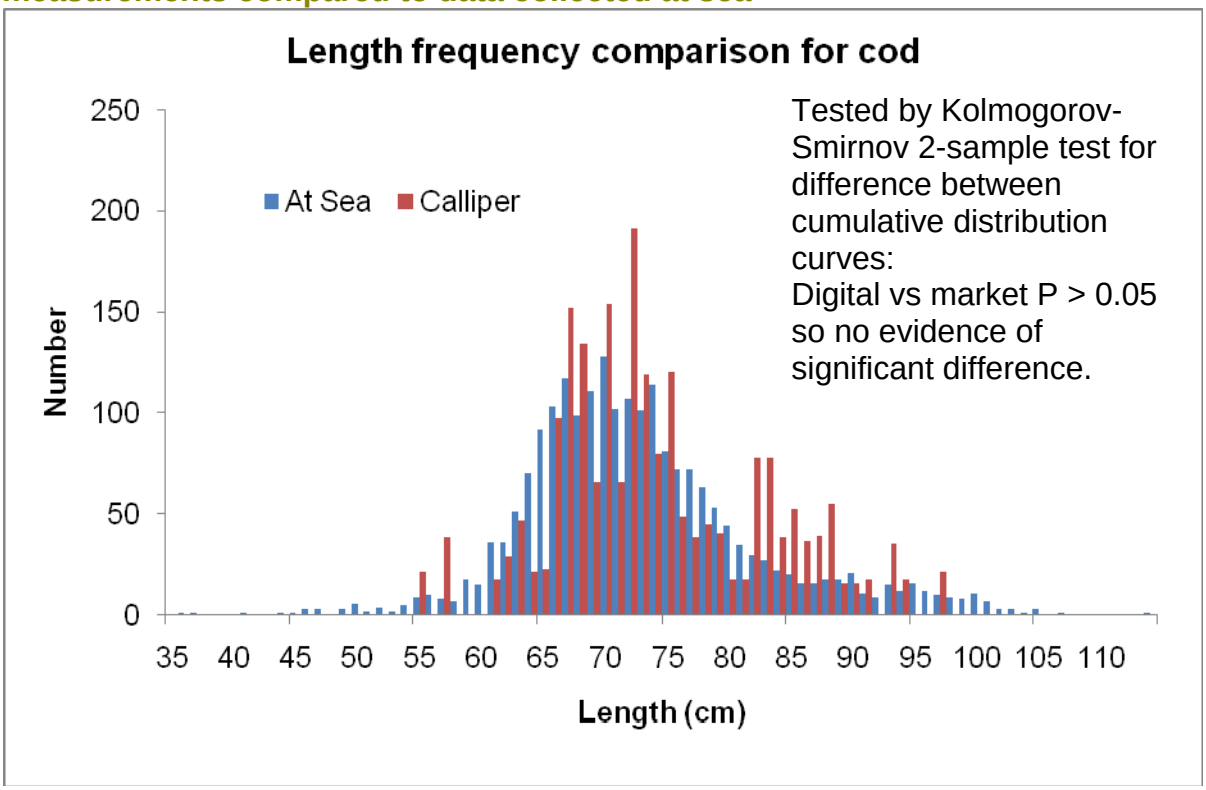
Digital calliper length frequency data was compared to length frequency data from the landed catch for sole to assess the accuracy of the calliper measurements. In order to gain a true reflection of the total catch length frequency distribution samples were taken from random hauls through the trip. Figure 11 shows the proportionate comparison between the two sets of data, which show a close correlation. The results show no significant difference between the two length distributions. This provides confidence that length measurement for sole can be reliably achieved even with a relatively basic camera and calibration setup.

Figure 11: Comparison of length frequency of sole from digital calliper measurements compared to data collected on landing



Length-frequency data was obtained from footage from a North Sea cod gill netter and compared to on board observer data as shown in Figure 12. Calliper measurements could only be taken from 5% of the total number of fish caught to which a raising factor was applied. This results in a weaker correlation with a significant difference.

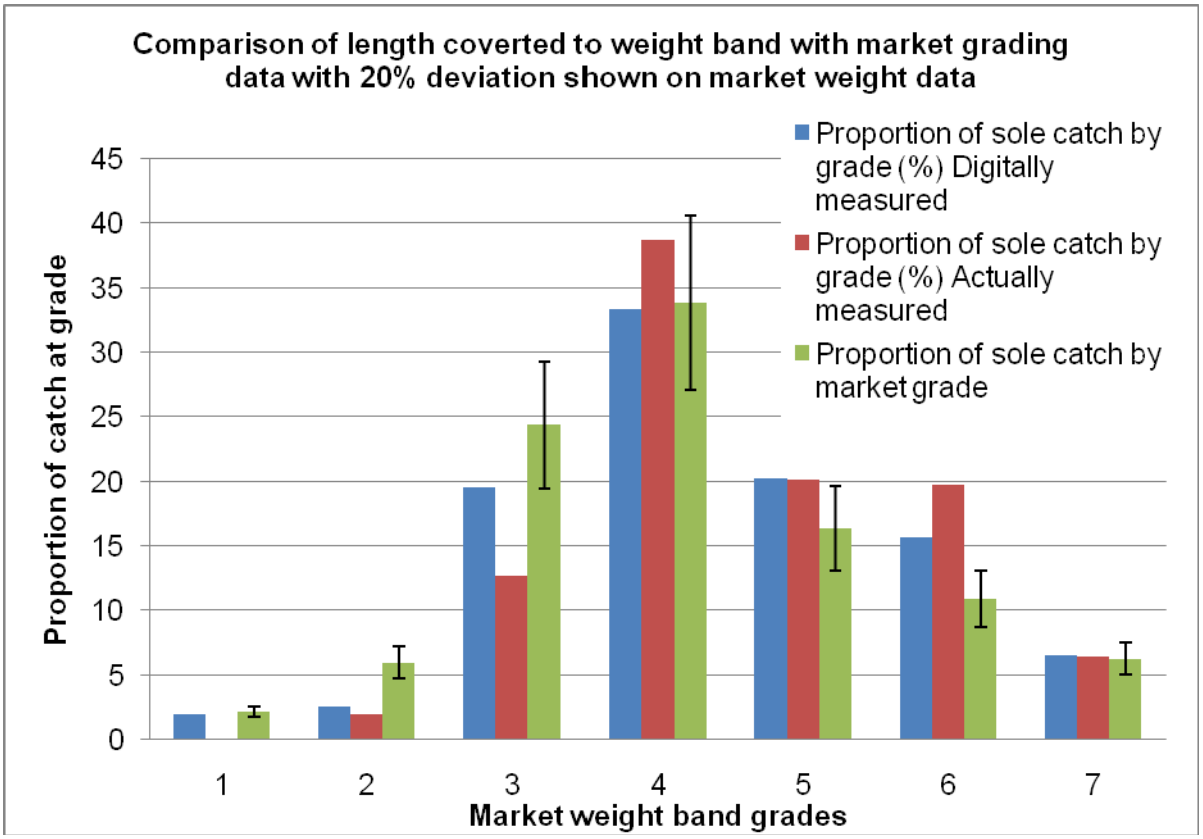
Figure 12: Comparison of length frequency of cod from digital calliper measurements compared to data collected at sea



The length-frequency data can be compared to the weight frequency of landed catches using market-grading data. This requires a length to weight conversion factor to be used, which is likely to be variable on a seasonal basis and subject to some error. For the purpose of the trial, standard length to weight conversions as used by the Centre for Environment, Fisheries and Aquaculture Sciences (Cefas) were used to convert length data to average weight data. The average weight data was then compared to market weight grade bands.

Figure 13 shows the results of the comparison between digital measurements converted to weight with market weight grading bands. There is less correlation between the two sets of data although it is interesting to note that the correlation is stronger between the digital and market data than between the actual measurements and market data.

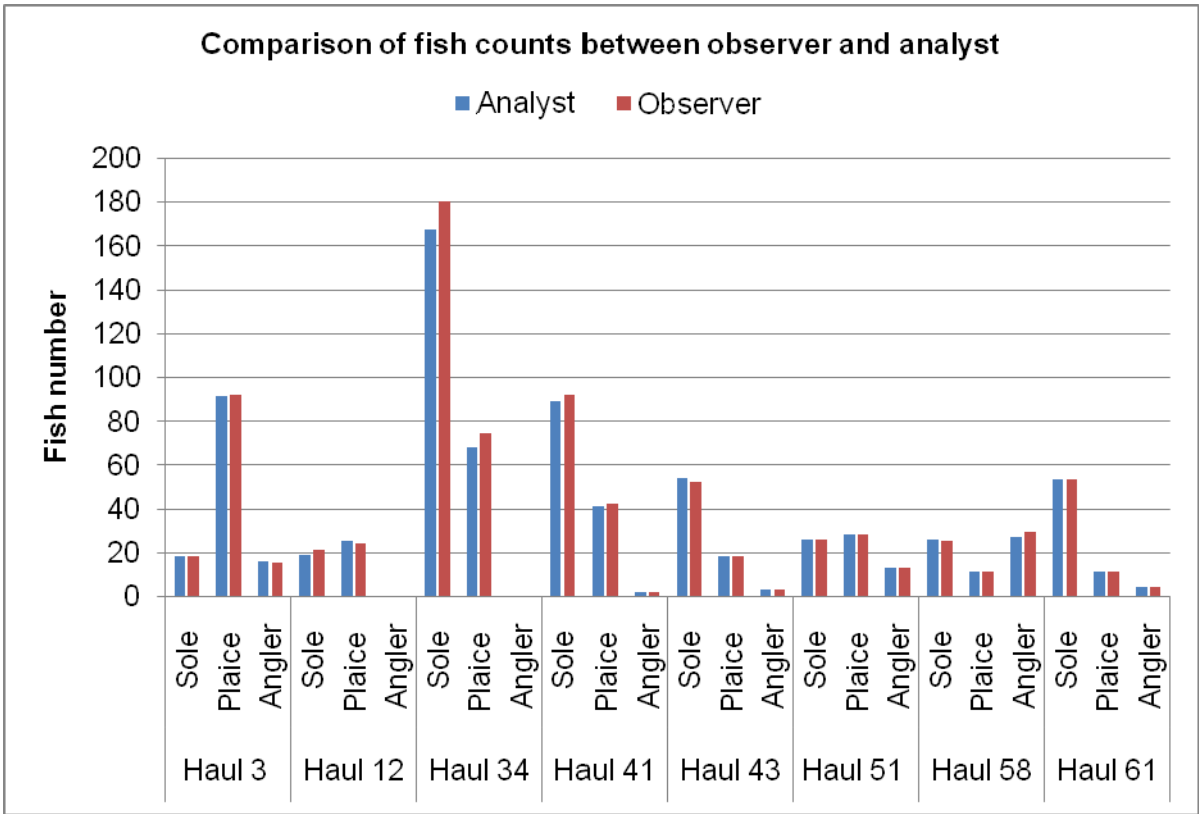
Figure 13: Comparison of fish lengths converted to market grading weight bands



In order to estimate catch weight on individual hauls using a length to weight ratio, the camera setup and fish sorting procedure need to allow for accurate counts of fish to be made as well as presentation to allow reliable measurement. Where all fish can be counted during a specific fishing operation, average weights can be applied to estimate a total weight.

Observer data from a beam trawler provided control data against which to test the reliability of counts made using CCTV footage. Figure 14 shows a very close correlation between control data and analyst counts of plaice, sole and angler showing that fish counts on this type of vessel is achievable.

Figure 14: Comparison of fish counts achieved by analyst compared to control data



Comparison of various catch estimation methods

Figures 15 and 16 shows a comparison of various methods of estimating beam trawl catches per haul for sole and plaice with observed weights obtained from weighing at sea by MMO observers. The results show generally a close correlation between the estimates made from CCTV footage by various means and the control data.

However, it can be seen that on occasion estimates derived from all methods with the exception of the scales readout can deviate by more than 20% from the control data.

Applying average weights (or expected weight frequency from grading data) to sole counts appears to show greater consistency in the accuracy when compared to the basket estimate. However these methods are time consuming when compared to a visual estimate of basket volumes. For plaice there appears to be greater consistency in the estimates from basket volumes than for length to weight conversions. This suggests that length-to-weight ratios for plaice are less consistent than for sole.

The ability to read the weight from motion compensated scales requires the co-operation of crew to ensure the view is not obscured and a dedicated camera to view the scales readout. The results for camera setup 1 with a camera viewing the scales show, as might be expected, that there is a precise correlation between the control data and the scales readout. Camera setup 2 did not allow for viewing of the scales readout. It should also be noted that the accuracy of the master's estimates in this series of hauls was through the use of the scales.

Figure 15: Estimates of sole catches compared to observer control data

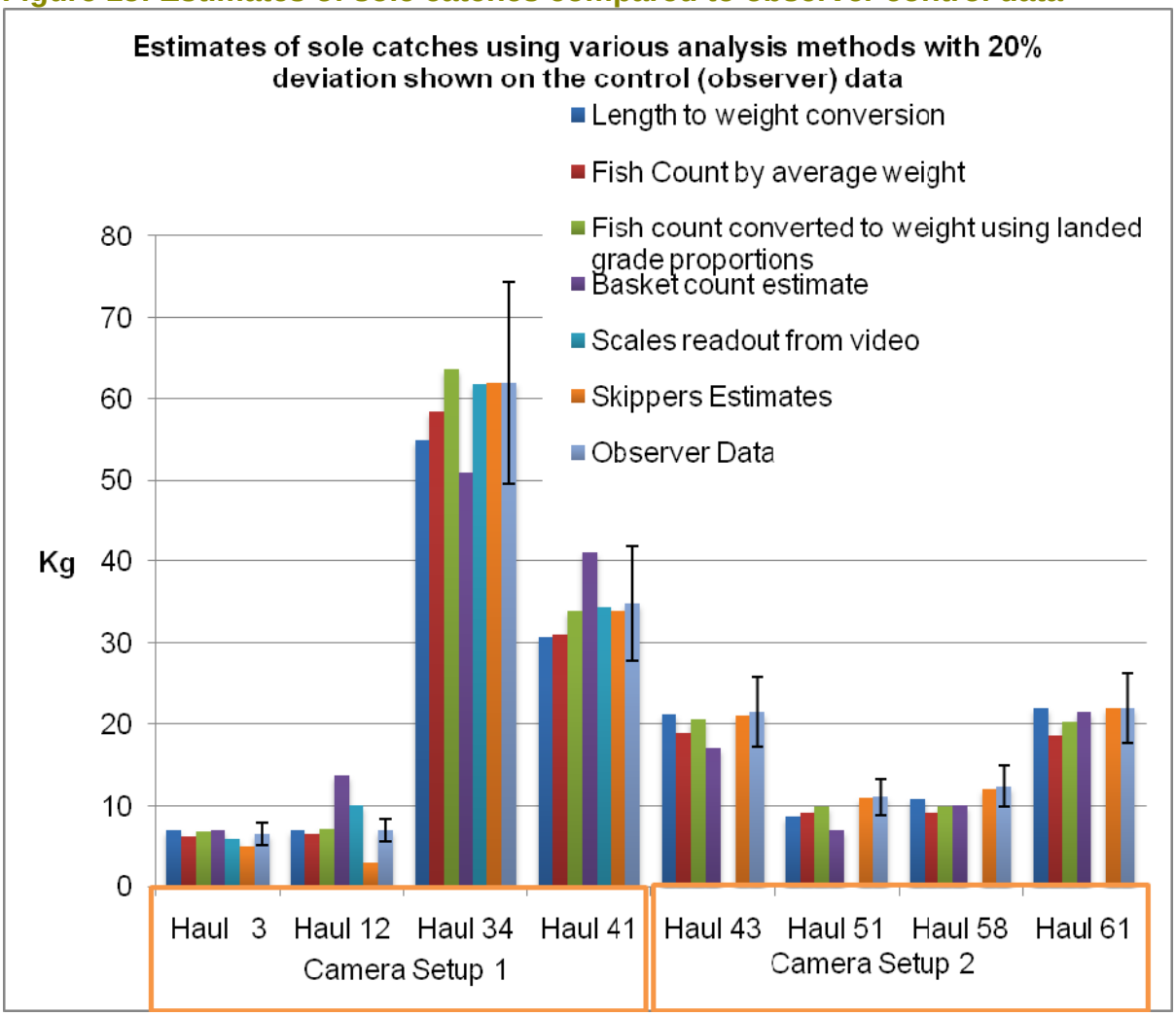
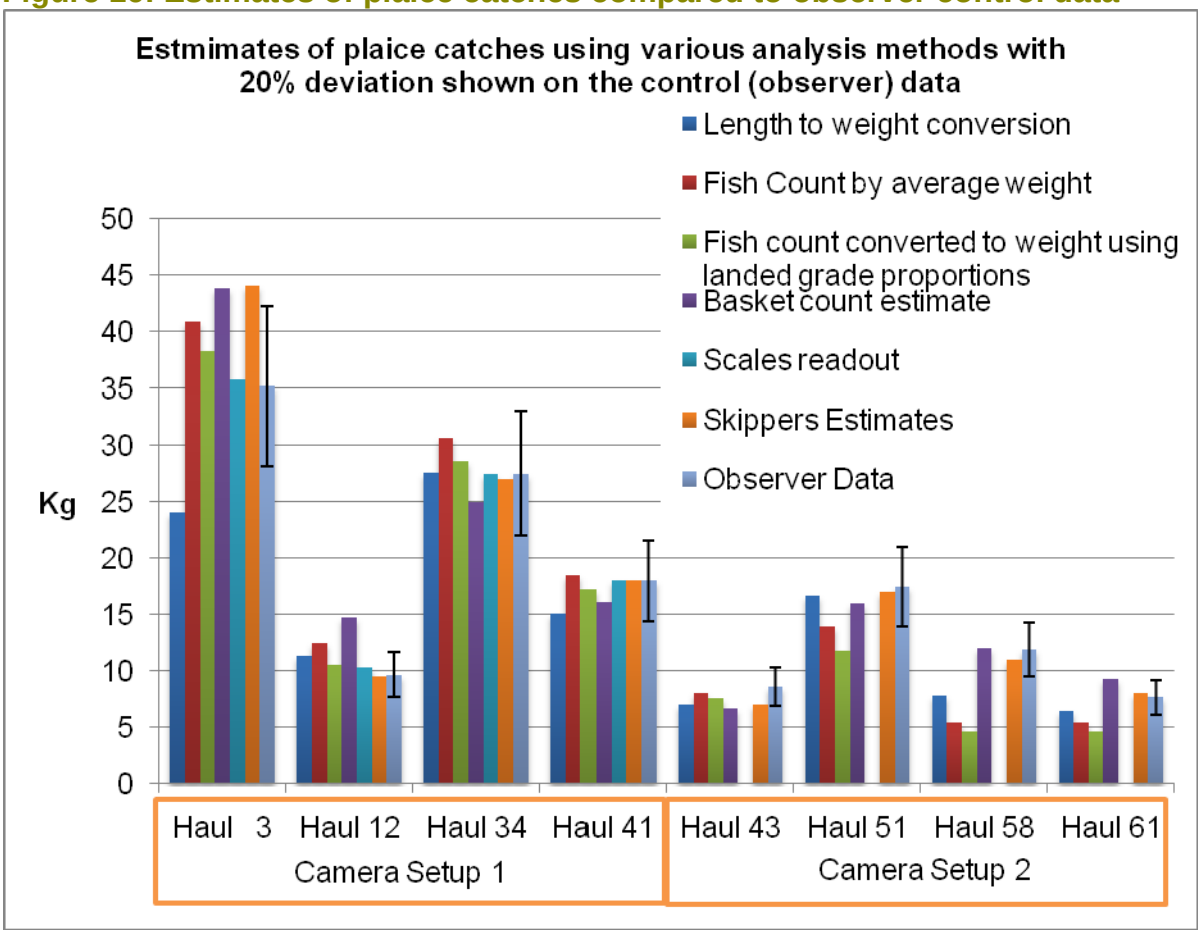


Figure 16: Estimates of plaice catches compared to observer control data



Analysis of individual hauls relies on the master providing catch records at individual haul level. This goes beyond the current control requirement of providing a catch record once every 24 hours except for vessels operating in the Norwegian sector.

Masters engaged in the trial have provided catch estimates for relevant species on each haul. However, this is time consuming and can be subject to significant margins of error where estimates of very small quantities have to be made. It is not envisaged that reporting on a haul-by-haul basis should become a mandatory requirement for all vessels, particularly those that carry out numerous hauls and catch a diverse range of species.

Typically, masters will make an estimate of catches from the fish room stowage at the end of each day and may report the catch in terms of numbers of boxes (with a unit weight value) of each species or a total weight in kilos. While motion-compensated scales are useful for masters to check the unit weight values for each species it would be an additional burden to weigh fish at each haul especially where frequent hauling events take place.

It is important in monitoring a fully documented fishery that there is a clear understanding of how masters are estimating catches and that the master has a clear understanding of how catch reports are to be audited. The trial demonstrates that these methods are highly dependent on the type of fishing operation and species involved.

The footage from the beam trawler observer trip was analysed to estimate total catch for full days fishing by aggregating the weights from consecutive hauls. The results are shown in tables 17 and 18. In this scenario one day in ten could be analysed to achieve a 10% sample to compare to daily logbook records.

The results show similar levels of deviation from control data and there is no evidence that the more long-winded catch estimation methods are more or less reliable than simple volumetric basket estimates.

Figure 17: Estimates of daily sole catches compared to control data for a full trip

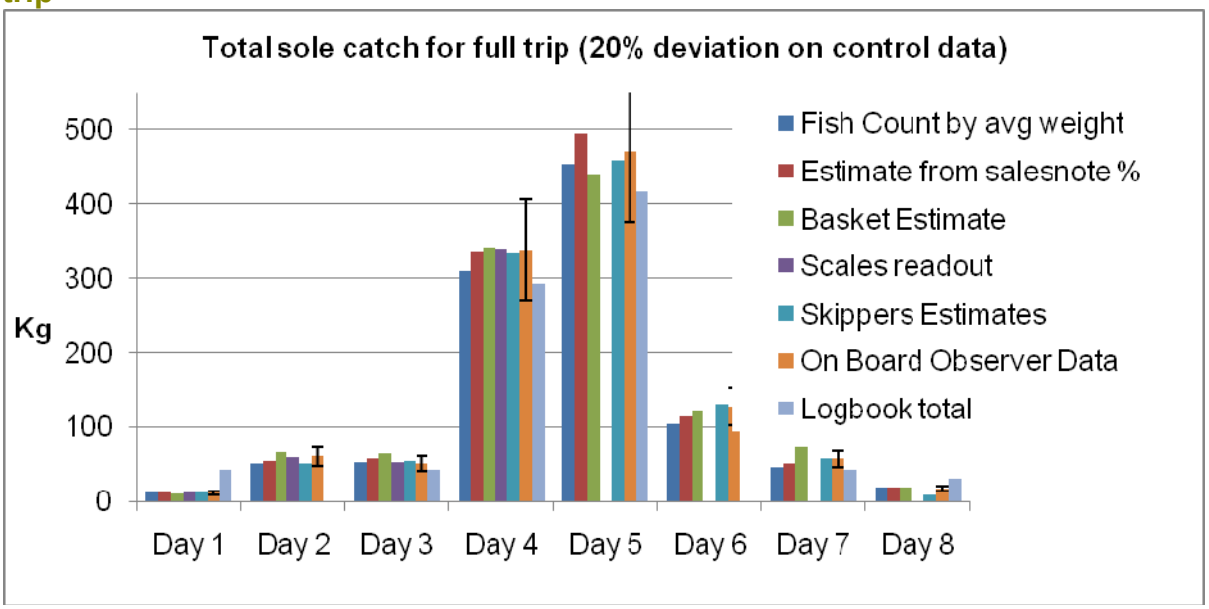
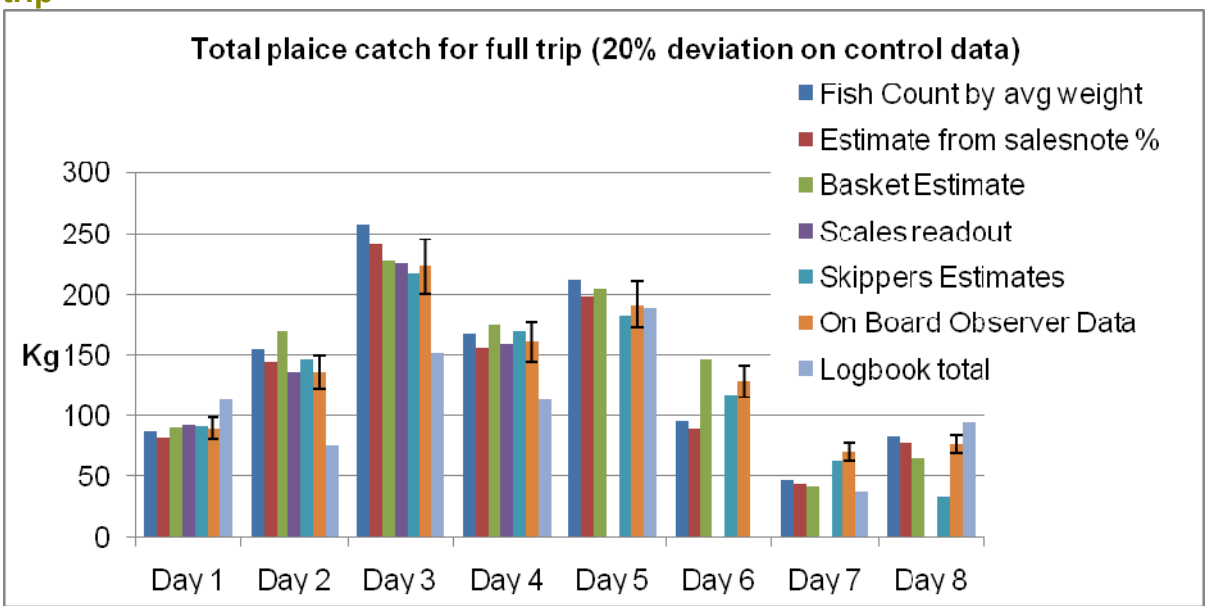


Figure 18: Estimates of daily plaice catches compared to control data for a full trip



Detailed examination of electronic logbook data showed that daily catches were out of sync in that the date attributed to a catch was one day ahead. Logbook data was also missing for one day. Catches were recorded to nearest full box in the logbook,

which also gives rise to reduced accuracy of the estimate. Overall the data suggests that estimation to within one full box can be consistently achieved through analysis.

Similar data was collected from gill net cod catches and compared against control data collected by observers. In this gill net fishery net hauling is carried out continuously over 18 to 24 hour periods, which necessitates the need to carry out analysis of footage for a full day of fishing. This is normally done at the rate of one day per 10 fishing days to maintain a workable sample rate. In order to test the efficacy of this system a full trip was analysed using various methods. Figure 19 shows that all methods came within 10% of the known weights with the exception of the method depicted by the red bar in which the CCTV analyst assigned a visual average fish length for each net hauled and converted to live weight based on the number of fish caught.

On this particular vessel, cod are usually passed to the fish room individually rather than in baskets. For the observer trip cod were transferred by basket in order for this to be assessed as a means of catch estimation.

Figure 19: Daily cod catch estimates compared to control data

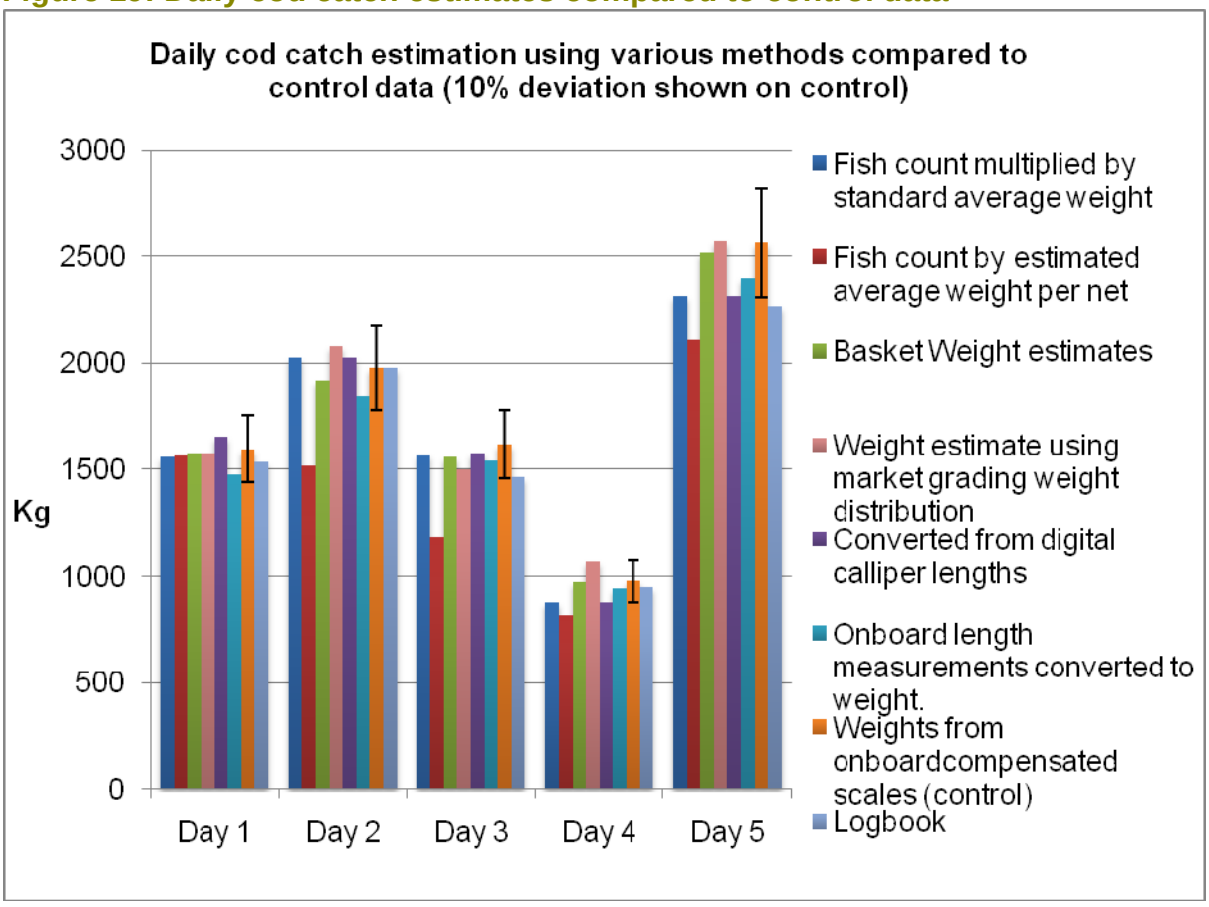
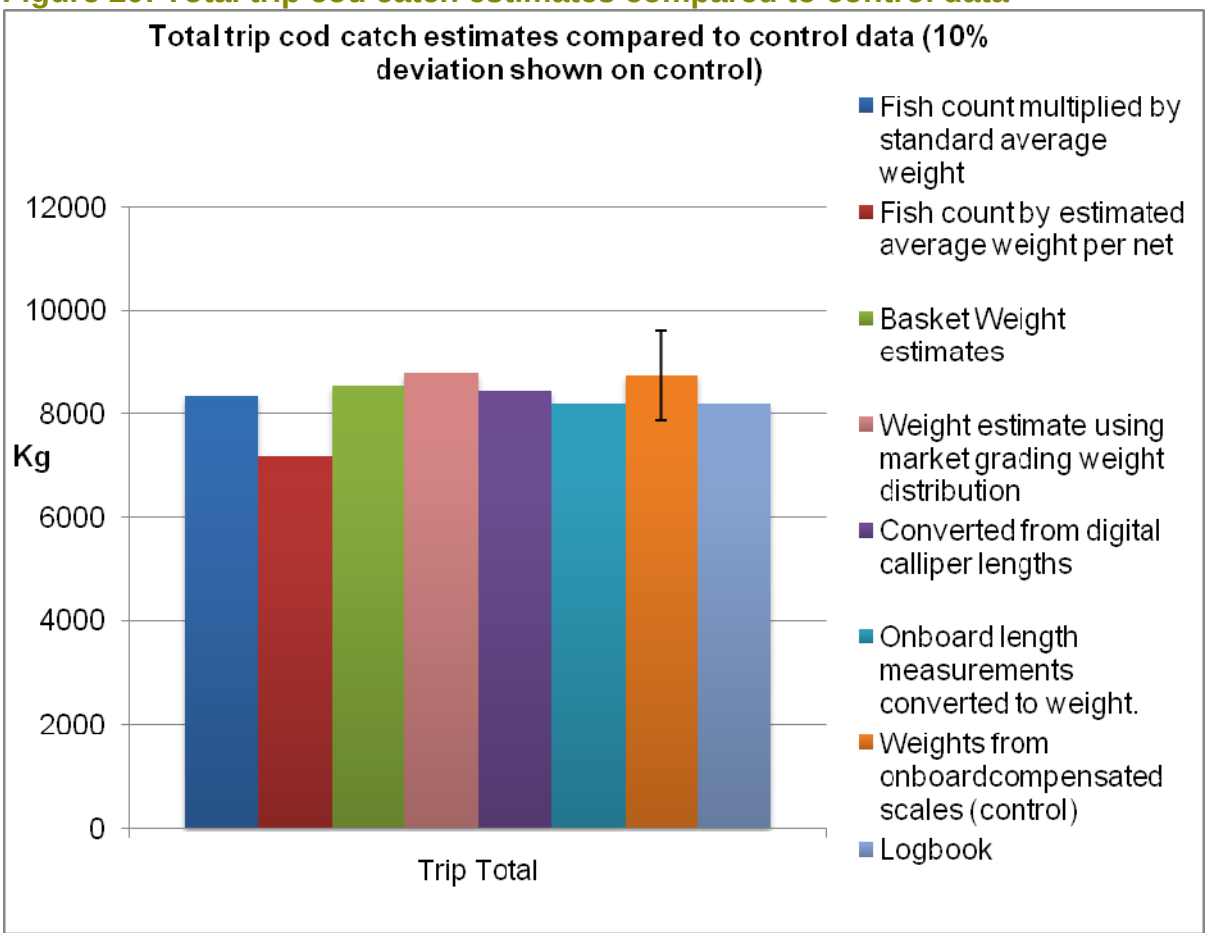


Figure 20 shows the comparisons of different estimates with the control data for the total catch for the trip which is consistent with the results for individual days.

Figure 20: Total trip cod catch estimates compared to control data

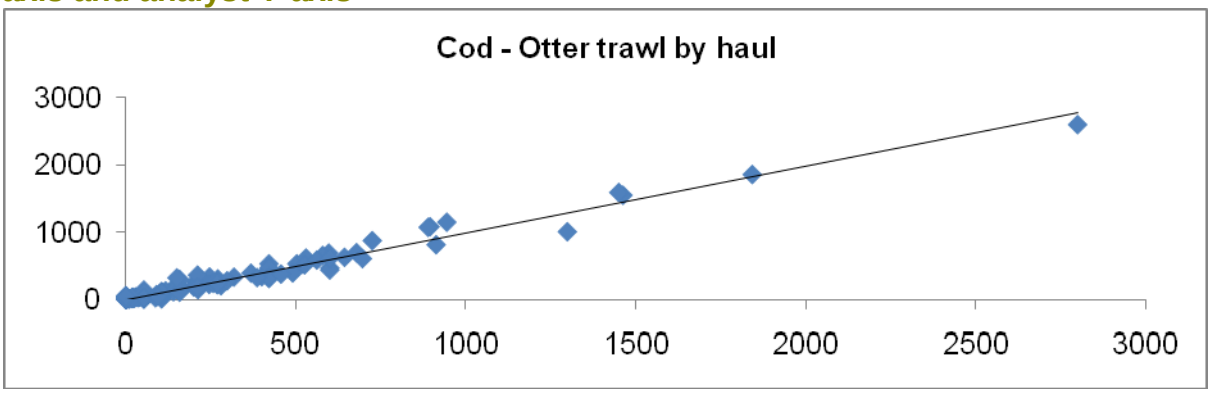


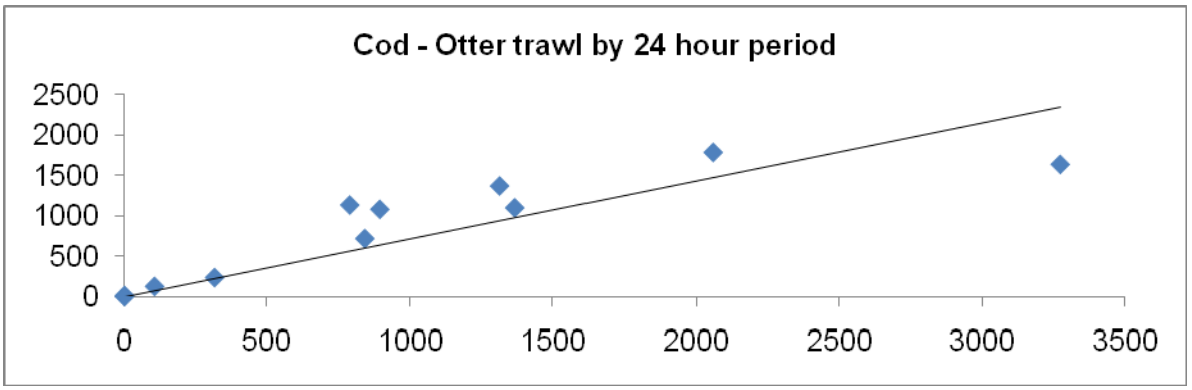
The results show that greater accuracy of catch estimation is achieved for cod catches than for the plaice and sole in the beam trawl fisheries. This is thought to be a result of the difficulty in estimating relatively small catches taken in individual beam trawl hauls compared to estimation of larger cod catches which are taken either in daily gill net operations of from long otter trawl hauls.

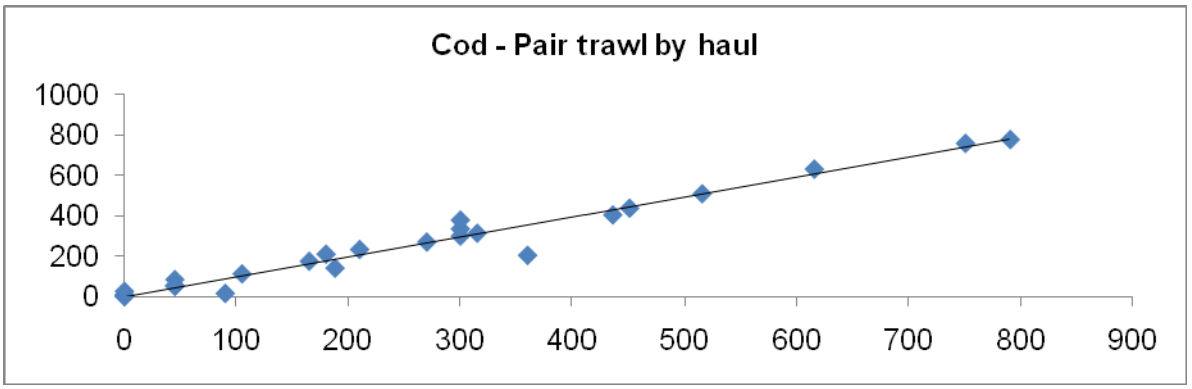
The results in general show that visual volumetric estimates (such as through counts of full baskets) are as reliable as estimates based on length measurements, which take considerably longer to achieve. For some vessels volumetric assessment could necessitate the need for alterations to fish handling procedures such as through the use of fish baskets where this method is not normally used.

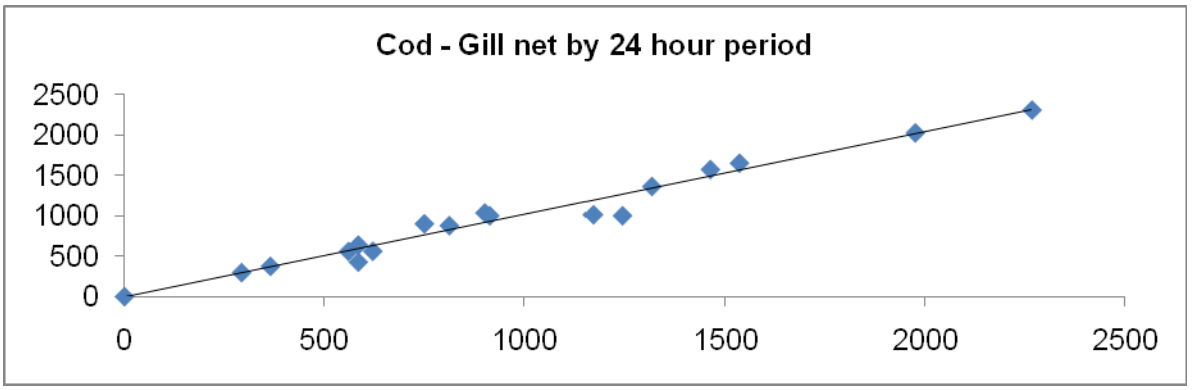
Figure 21 shows the comparison between all 2012 analysis estimates and catch records.

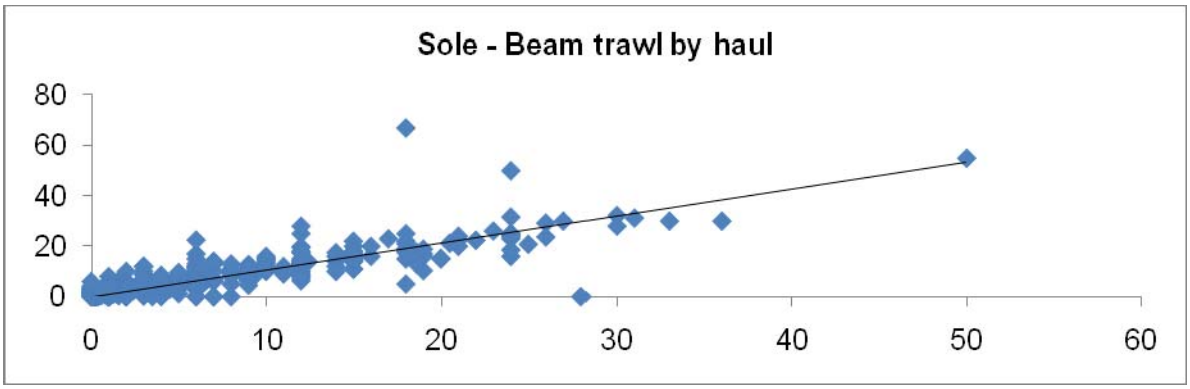
Figure 21: Catch (kg) comparison between estimates made by the master X-axis and analyst Y-axis

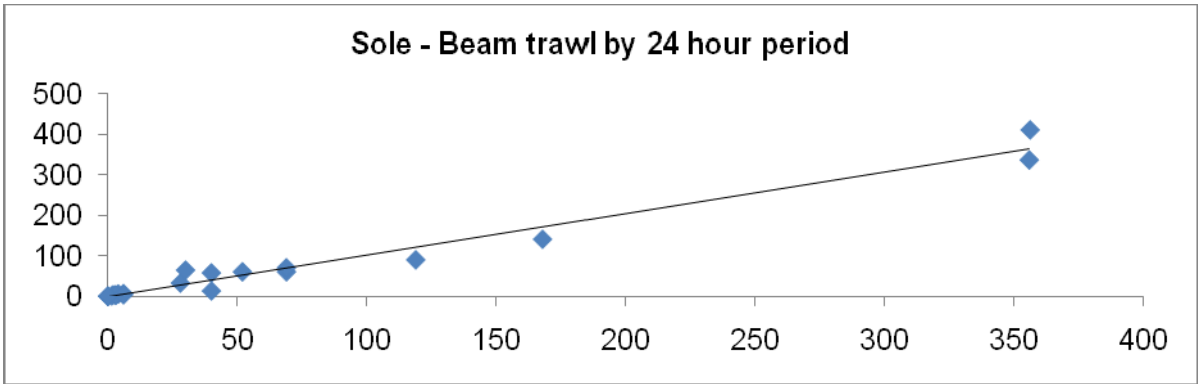












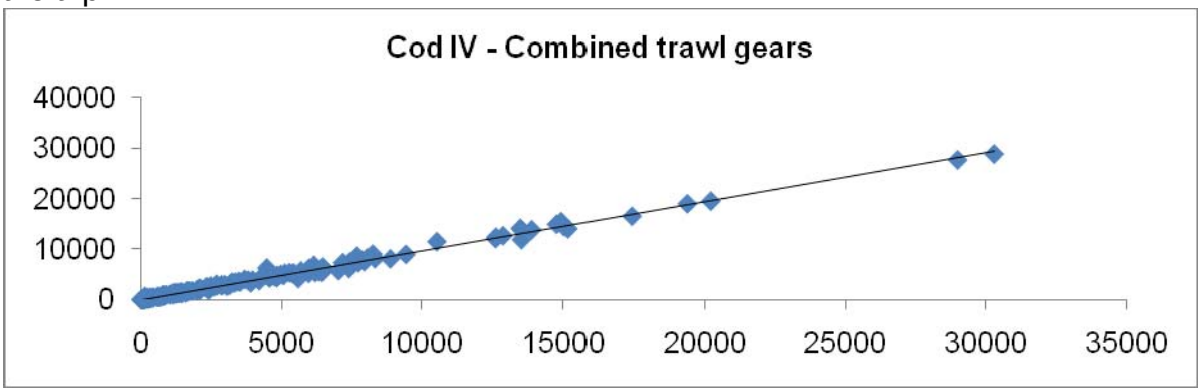
Current control regulation requires catch reports to be recorded every 24 hours. In the Norwegian sector, where catch reports are required to account for the catch for each haul, masters participating in the trial provided catch estimates on a haul-by-haul basis, which represents an additional burden especially in the beam trawl fishery where hauling events are more frequent than for otter trawlers.

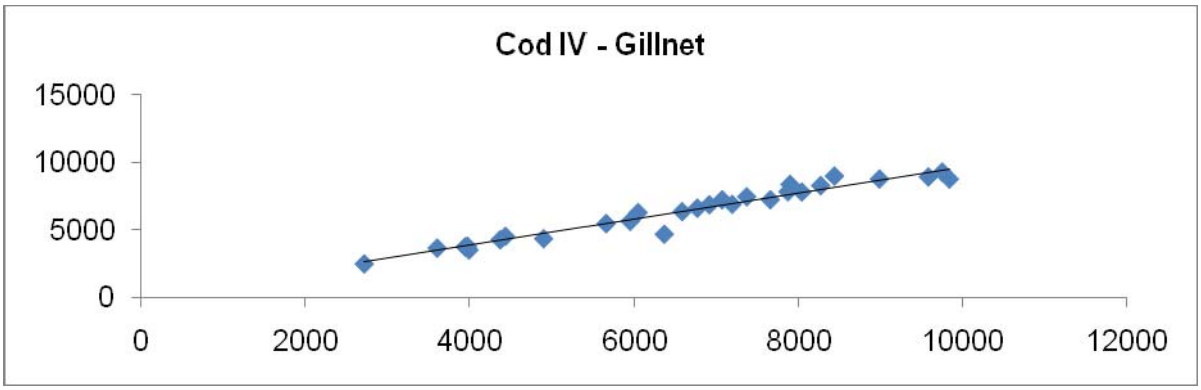
It was therefore decided to look at comparisons over 24-hour periods in order to reduce this burden. There are insufficient 24-hour comparisons to draw firm conclusions but the results suggest that greater accuracy of catch records is achieved from 24-hour periods where small catches subject to a large error are aggregated for estimation.

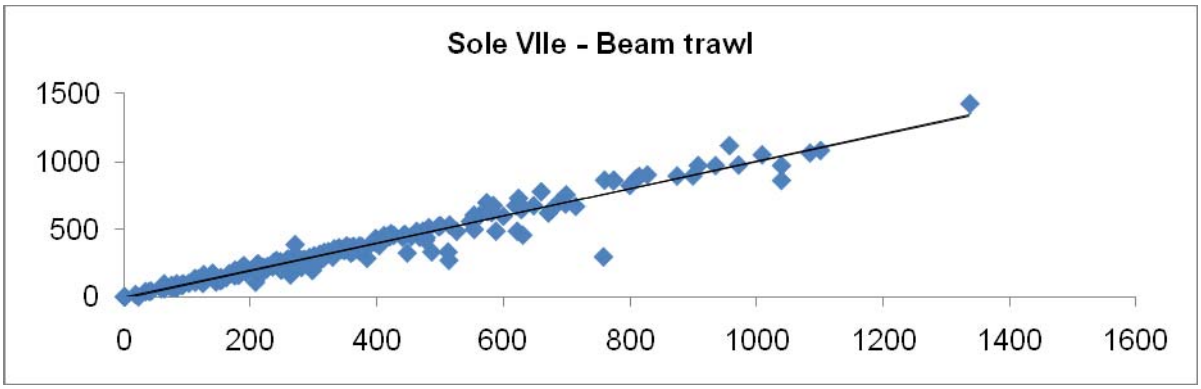
Figure 22 shows the comparison of landed weights of catch in live weight compared to the total logbook estimates. It can be seen that in all cases there are deviations in terms of both over and under estimating the total catch some of which are outside the 10% tolerance. The trend in accuracy of logbook estimates reflects the trend in estimates in 24-hour periods or haul-by-haul estimates but with noticeably less deviation in the case of sole catches reported at trip level.

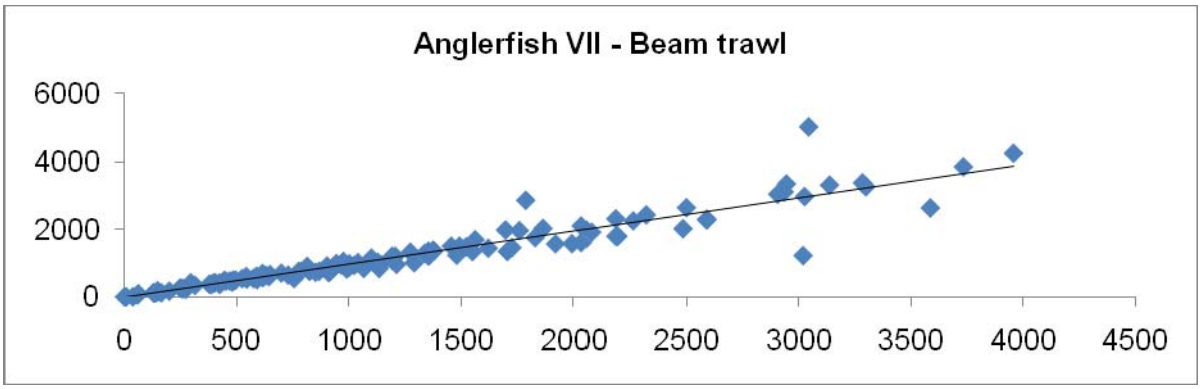
Figure 22: Comparison between the landed weights converted to live weight with the logbook live weight estimate

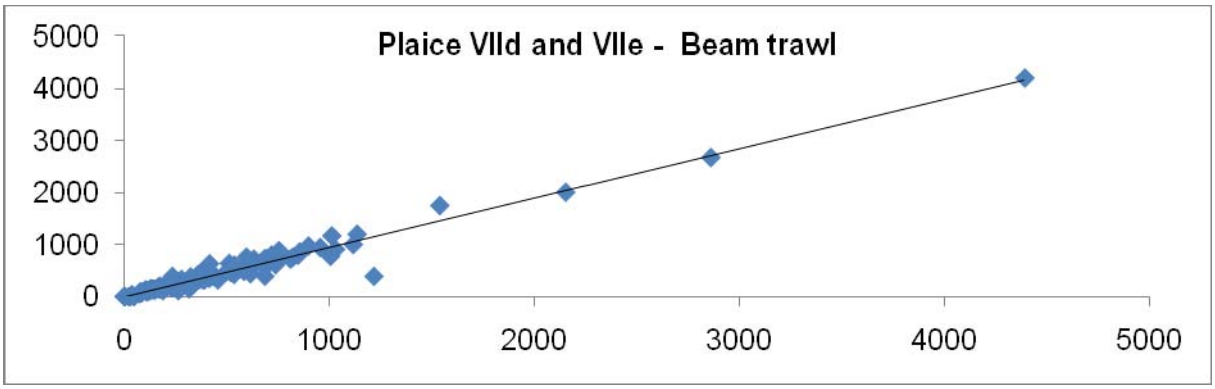
The X-axis represents live weight of catch and Y-axis shows the logbook estimate for the trip.











Assessment of EM audit capability

In order for an audit system to be effective there needs to be sufficient confidence in methodologies to be able to assign a result, whether a score or a simple pass or fail. Such a system would need to give confidence and transparency both to regulators and vessel operators. An effective audit system has been developed in the British Columbia hook and line fishery which compares counts of fish by CCTV analyst and vessel logbook. Comparing fish counts is clearly more definitive than comparing weight estimates. Nevertheless the process of agreeing a trusted scoring system took over two years to develop (Stanley et al, 2011).

This trial has not sought to develop an audit system that would provide sufficient confidence to impose sanctions relating to catch estimates, however it does provide a baseline to work from, should such a system be developed with a sound statistical basis. The data does support sufficient confidence to provide feedback in an advisory capacity and to identify significant discrepancies between reported catch and observed catch. The ability to monitor length frequency of catch as it is processed shows potential as a means of monitoring for subsequent high grading.

It is considered that although retained catch audits have potential, an operational programme should concentrate initially on higher level audits relating to data integrity, discard events and catch records in respect of area of capture and effort. The results from full retention monitoring and length measurements also show potential for establishing whether discarding or high-grading takes place prior to landing. The risk of interference with EM systems needs to be considered initially and what system of sanctions is in place to provide sufficient deterrent to deliberate tampering or failure to maintain sufficient duty of care. A vessel-monitoring plan, which is customised to the vessel and agreed by the master, is considered to be an appropriate method of establishing a common understanding of monitoring requirements. This can detail any specific catch handling and reporting requirements according to the fishery.

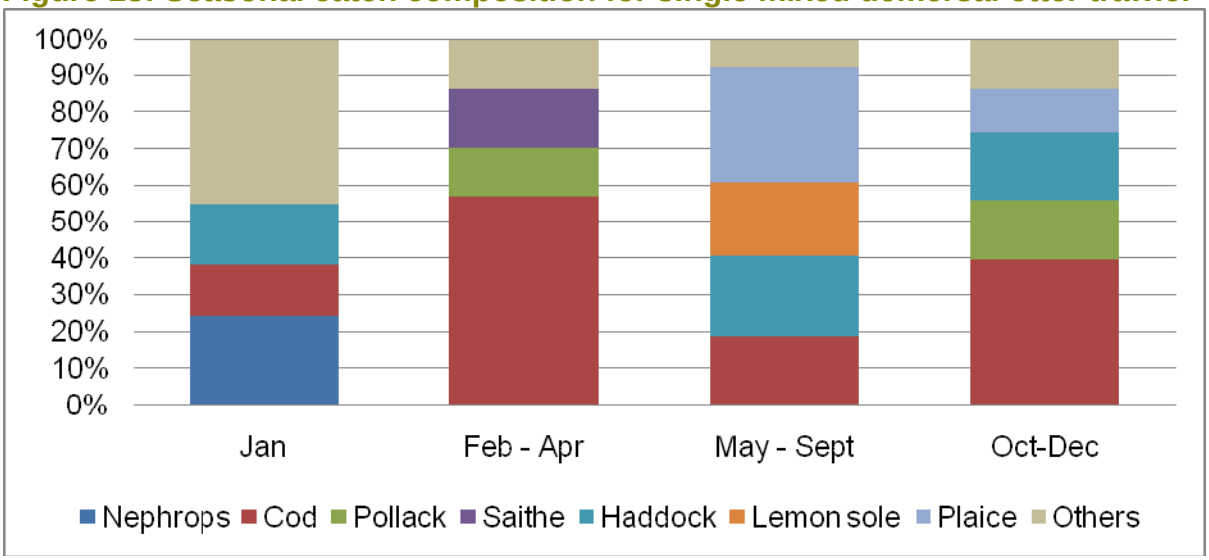
Consideration of mixed fisheries

North Sea mixed fisheries

Vessels engaged in North Sea catch quota trials targeted various species on a seasonal basis with some fishing more exclusively on large mesh gadoid fisheries such as cod and saithe, while others targeted mixed demersal fisheries using smaller mesh nets particularly with codends of less than 120 mm over the summer months.

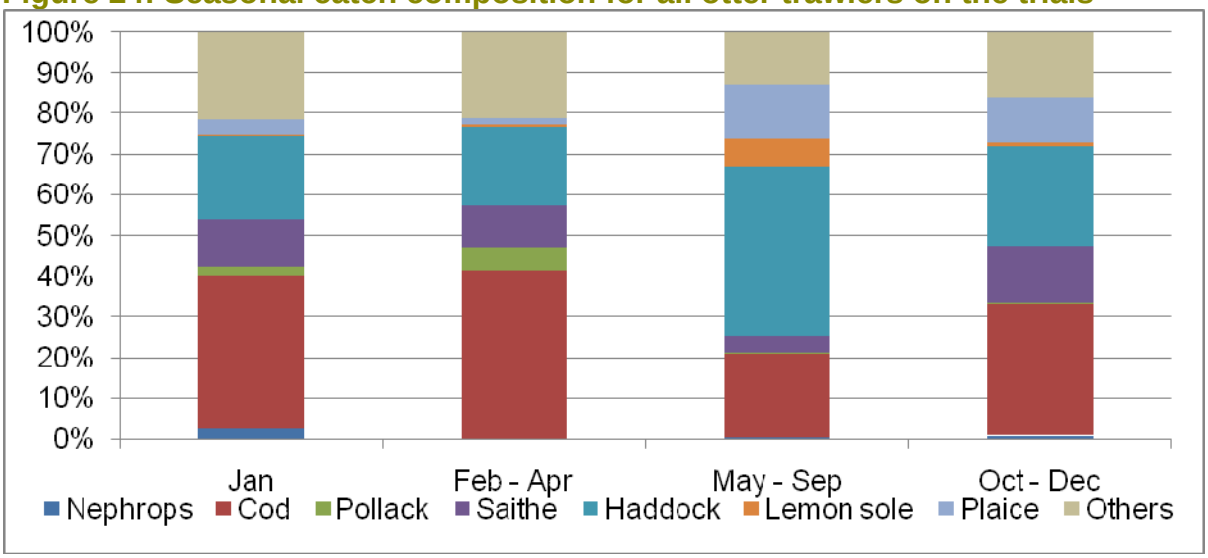
One vessel was examined in detail to assess the implications of catch quota management not just for cod, but for a range of species in mixed fisheries. Figure 23 shows an example of seasonal North Sea mixed fisheries based on landings data from one vessel.

Figure 23: Seasonal catch composition for single mixed demersal otter trawler



This compares to all otter trawl vessels on the trial as shown in Figure 24, which suggests that gadoids are the predominant target species.

Figure 24: Seasonal catch composition for all otter trawlers on the trials



The spatial variation in fisheries is highlighted from the sensor data in Figure 25. The vessel activity is colour coded with black tracks showing transits, red tracks showing gear with 107 mm mesh size deployed and blue showing gear with 120 mm+ gear deployed. The grey tracks show transits and non-fishing cable-guard patrols.

Figure 25: EM sensor data showing track of North Sea trawler with 10-second position intervals

Colour coding for activity and mesh size in use

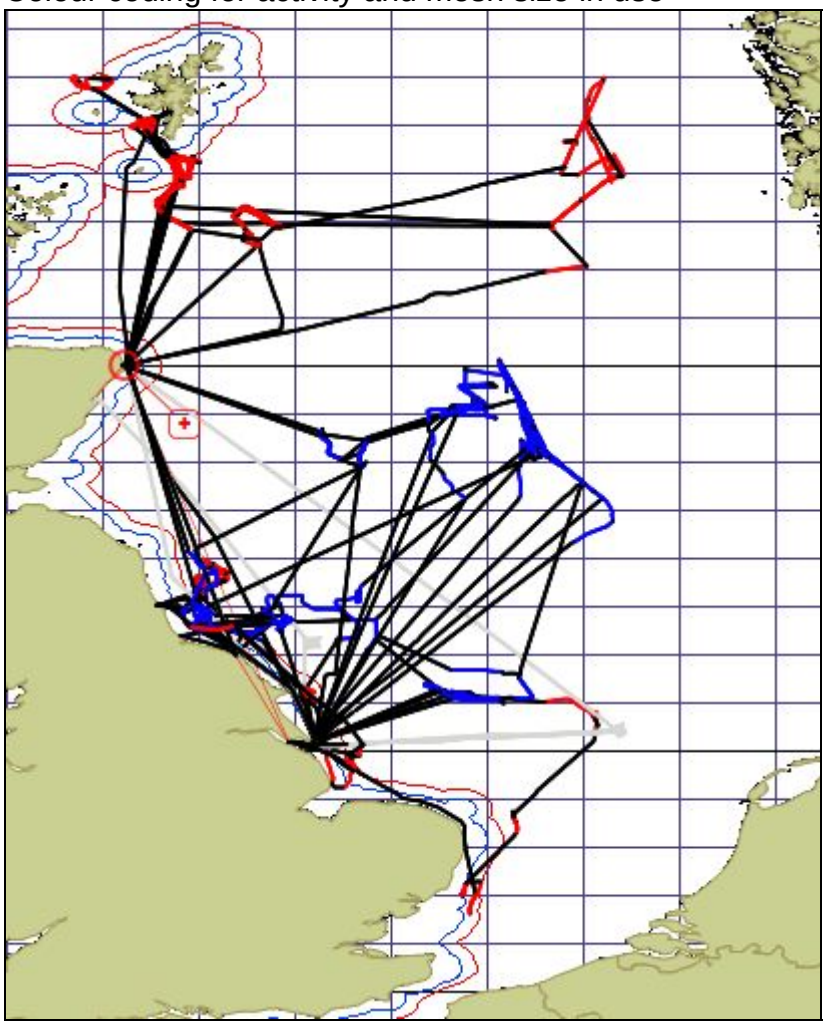
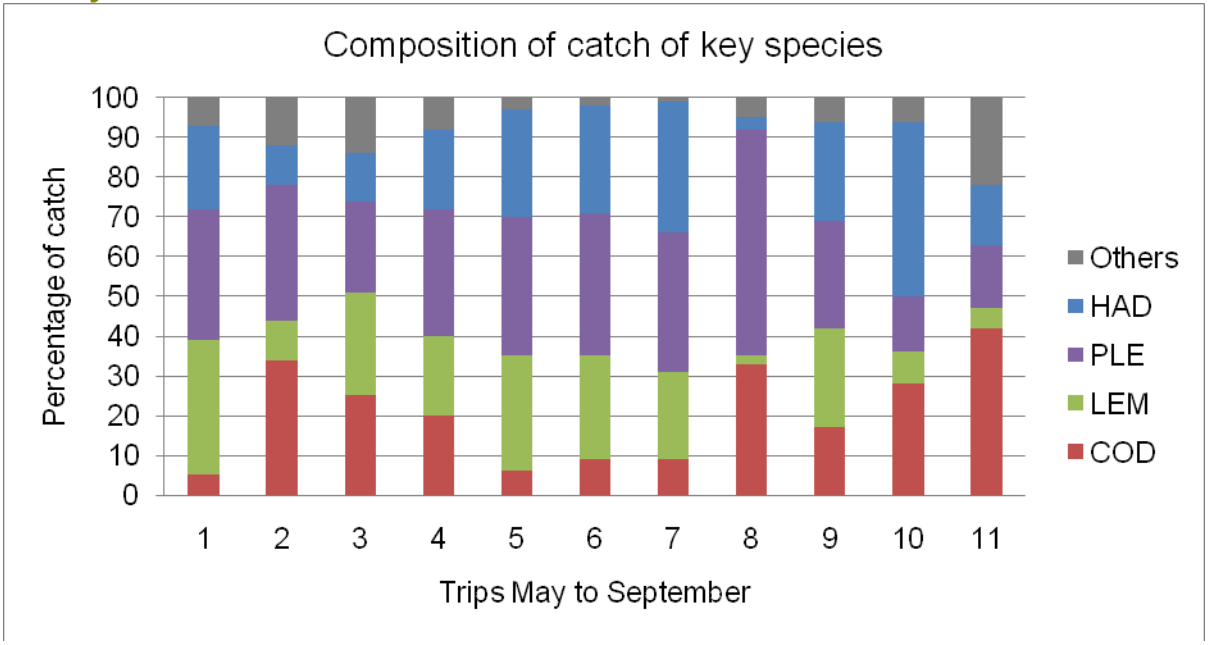


Figure 26 shows the proportion of total catches that were made up of cod, lemon sole, plaice and haddock from May to September. The combined catch of lemon sole, plaice and haddock typically make up about 75% of the total catch. The catch of cod in this mixed demersal fishery is considered to be relatively incidental rather than a targeted component of the catch as the small size distribution attracts a relatively low price per kilogram.

The master demonstrated that certain grounds regularly hold a high abundance of juvenile cod that might be avoided to some extent under a catch quota management system. Nevertheless, juvenile cod abundance appears to be often unpredictable. Where all catches count against quota uptake there is considered to be greater incentive to move on from high-abundance areas. Catch quota vessels were provided with more days at sea as an incentive to allow them to move on from areas with a high abundance of juvenile cod.

Figure 26: Relative proportions of key species in North Sea mixed demersal fishery

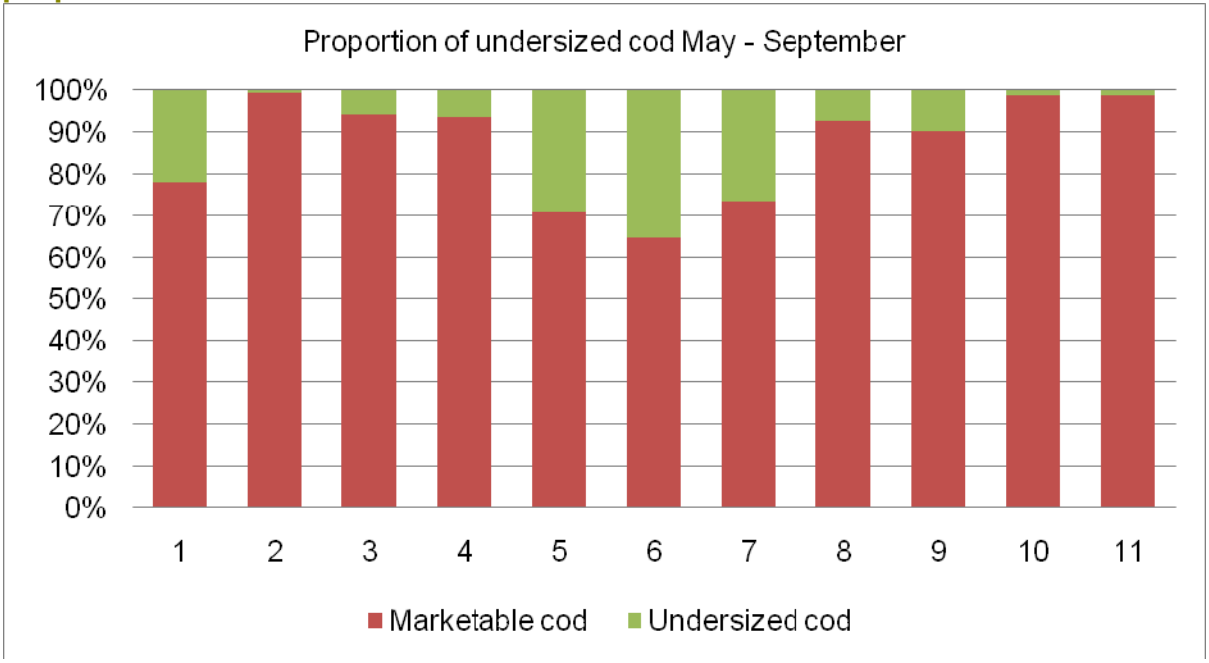


Current technical rules relating to cod in the North Sea (European Commission, 2001) allow no more than 20% of cod as a proportion of total retained catch when using a codend mesh size of less than 120 mm. It can be seen from Figure 25 that this requirement was not met on 5 of the 11 trips. The vessel was provided with derogation from the 2001 North Sea catch composition rules given that all cod catches counted against quota which should incentivise the Master to avoid juvenile catches where possible.

It should be noted that the North Sea technical provisions of 2001 were specifically designed to protect juvenile cod by effectively increasing the mesh size to target cod to 120 mm although this measure does not necessarily prevent juvenile cod capture in smaller mesh fisheries where vessels can discard in order to meet the requirements.

Over the 11-trip period the vessel landed 202 tonnes of catch of which 15% was marketable cod (31 tonnes) and 1.5% (3 tonnes) was undersized cod. The component of undersized cod amounted to 10% of the total cod catch, which is therefore indicative of the discard rate in this fishery. The proportions of undersized to marketable cod catches are shown in Figure 27.

Figure 27: Catches of cod in North Sea mixed demersal fishery showing proportions of marketable and undersized



On aggregate therefore, the vessel has caught less than 17% cod over the 11 trips during which codends of less than 120 mm were used. This is consistent with the aims of the North Sea technical regulations but only when taken across the full period as opposed to individual trips or at any point during any given trip.

Furthermore, the vessel did not have to discard marketable cod in order to remain within the catch composition rules.

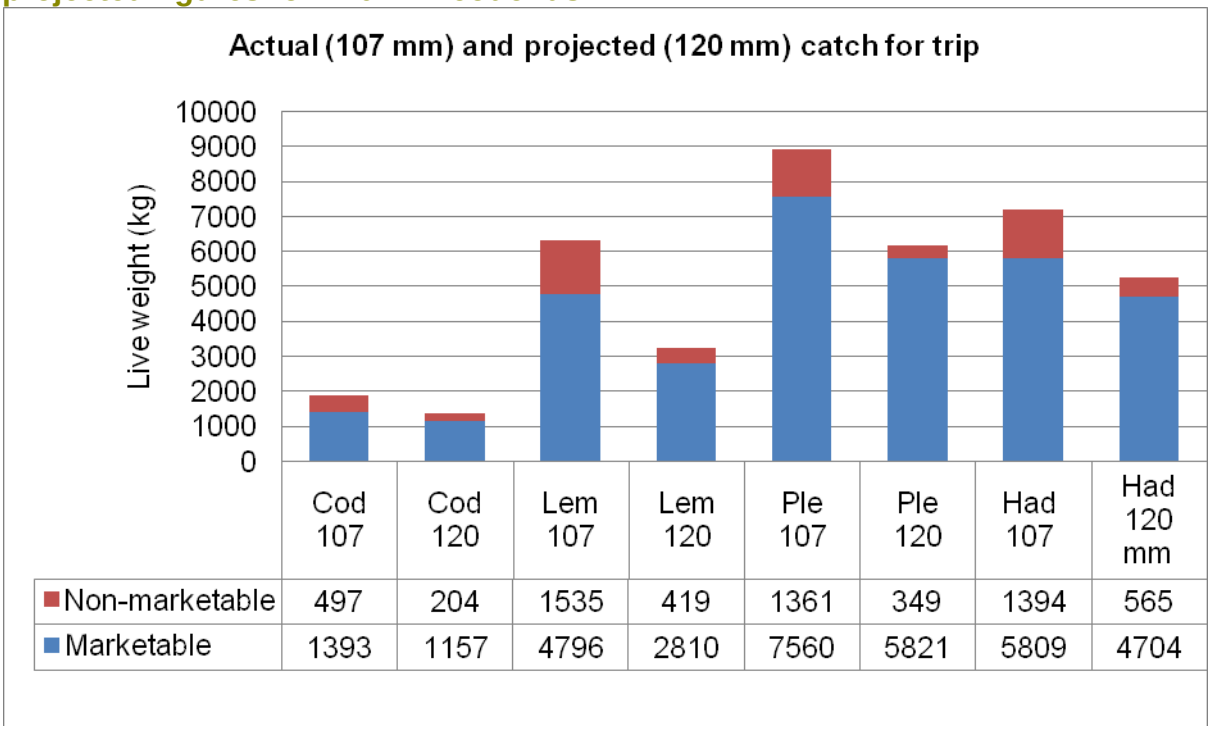
Simultaneous comparisons were made using 120 mm and 107 mm codends of the twin rig trawl to assess the implications of having to use the larger mesh size to avoid infringing the 20% cod catch composition rule both in terms of catch composition and potential loss of revenue when using more selective gear. To gather data for this purpose, 7 tows (of a total of 21 tows) totalling 48 hours were conducted at various locations during a mixed demersal commercial fishing trip. Data has been aggregated across the 48 hours of fishing effort which comprised 33% of the total effort for the trip. This level of gear and catch rate comparison is similar to that carried out on previous trials in this fishery comparing 100 mm and 120 mm codends (Cotter et al, 2004).

Figure 28 shows the relative catches of cod, lemon sole and plaice using 120 mm and 107 mm codends. Lemon sole is not subject to a minimum size and all catches can be, in theory, marketed. However, in practice small grades of lemon sole are generally unmarketable. The relative catches have been calculated from the sampled tows and raised up to full trip level based on the discard rates found. There are reductions in catches across all three species reflecting the relative selectivity between the two mesh sizes. Over the entire trip it is estimated by raising the values to total trip effort that, if using 120 mm codends, there would be a reduction in both marketable and non-marketable catches.

The reduction in the proportion of undersized fish caught is higher than the reduction in marketable catch. In terms of potential loss of revenue it is estimated that for this trip the vessel would have lost approximately £8,000 of catches for the three species considered. Further losses would be likely for other species.

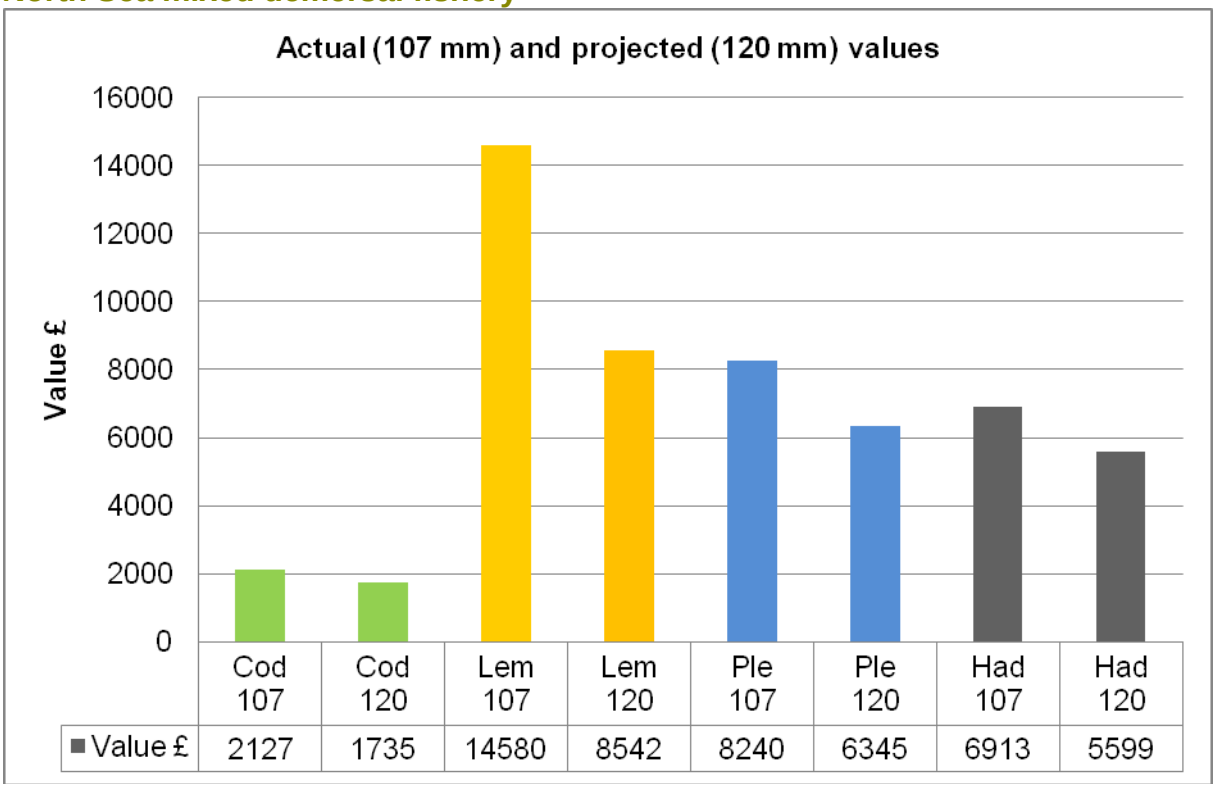
Under a catch quota management system where all catches count against quota, but with greater flexibility in terms of gear and catch composition rules, this demonstrates that fishers will need to carefully consider the balance between selectivity or juvenile fish avoidance, quota availability and profitability in mixed fisheries such as this. The larger mesh size provides for less unmarketable catch being caught for which quota would need to be sourced, with the risk of the fishery becoming less profitable. With 120 mm codends, a smaller amount of undersized plaice and lemon sole would be landed from this fishery but with reduced overall economic return as shown in Figure 29.

Figure 28: Catches and discards of key species with 107 mm codends and projected figures for 120 mm codends



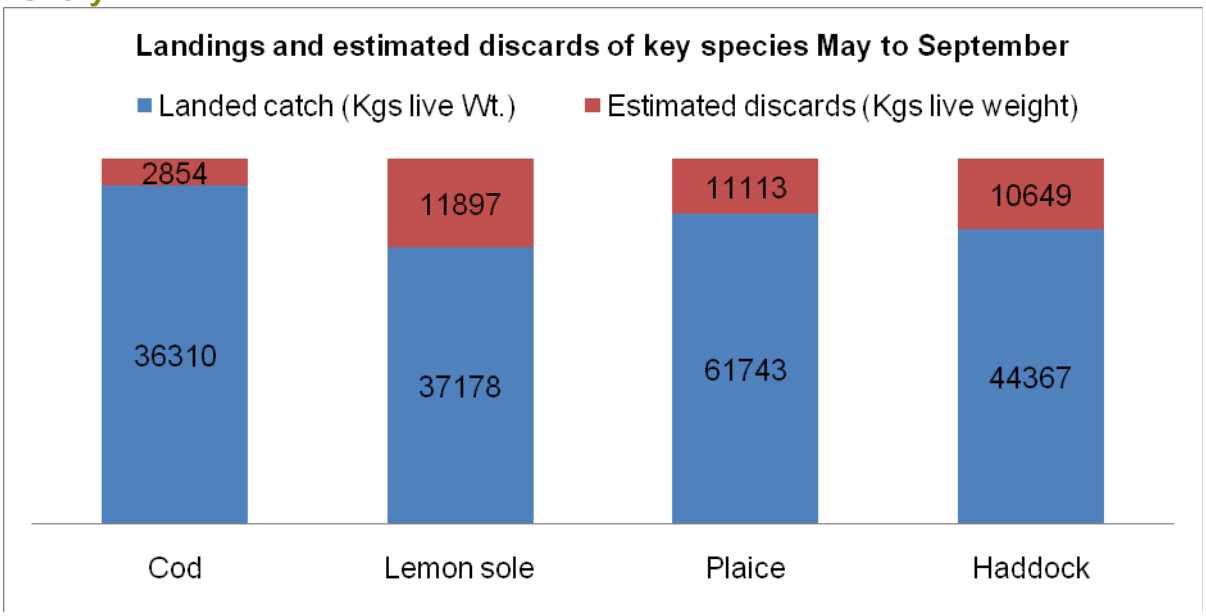
	Cod 107	Cod 120	Lem 107	Lem 120	Ple 107	Ple 120	Had 107	Had 120 mm
Non-marketable	497	204	1535	419	1361	349	1394	565
Marketable	1393	1157	4796	2810	7560	5821	5809	4704

Figure 29: Projected loss of value for key species using 120 mm codends in North Sea mixed demersal fishery



Observed discard rates were 24% for lemon sole and 15% for plaice when using 107 mm codends. Assuming these rates are consistent from one trip to another, Figure 30 shows the projected discards as a percentage of the total catch. Under a discard ban for these species the vessel would need to acquire additional quota to allow the discarded portion to be landed if further unwanted catch avoidance is not possible.

Figure 30: Total catch and estimated discards in North Sea mixed demersal fishery

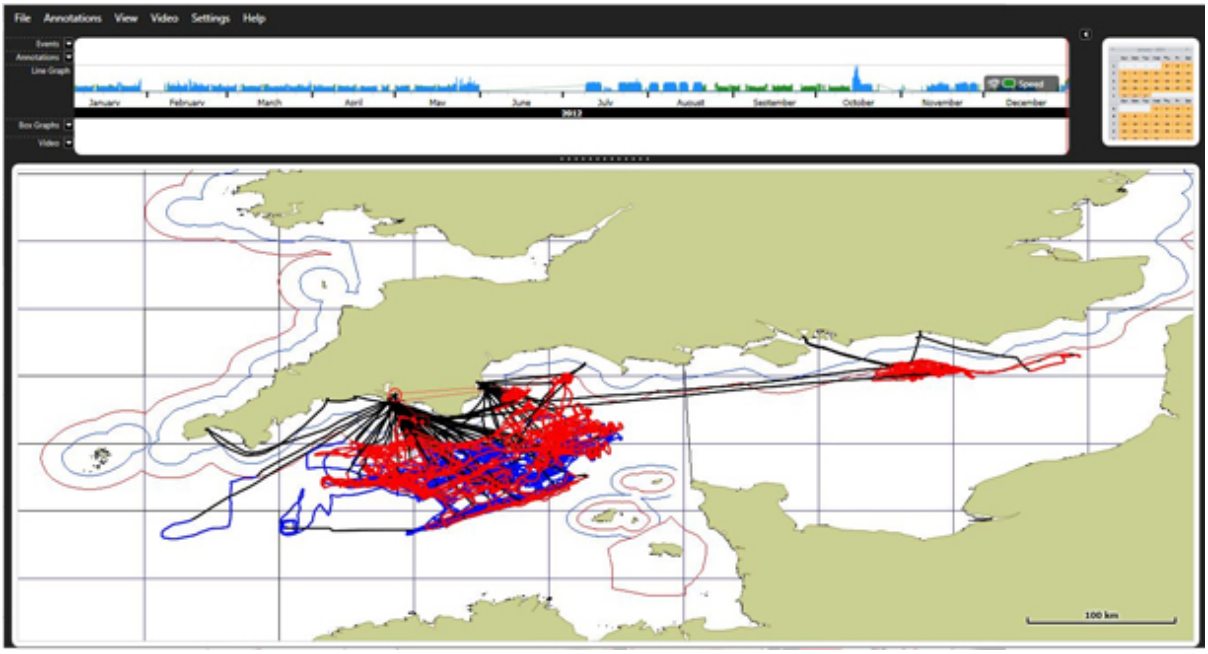


* Discards for cod taken to be the landed undersized component as this species was subject to a discard prohibition.

South West mixed fisheries

4 of the 7 vessels engaged in trial in the South West beam trawl fishery were committed to discard free fisheries for 5 species. All vessels were engaged in predominantly offshore fisheries outside 12 nautical miles as represented by the track of one vessel in Figure 31.

Figure 31: EM sensor plot showing the track of one beam trawler during 2012
10 second position intervals, track colour indicating transits and fishing operations with different mesh sizes.



One of these vessels joined the scheme in the autumn of 2012 with the aim of targeting cuttlefish. This is a mainstay species for the South West fleet and is generally an offshore fishery with a mixed demersal catch using large codend mesh sizes of up to 100 mm. The cuttlefish price per kilo reduced significantly in 2012 when compared to prices in previous years, making the profitability for this vessel less attractive.

The vessel returned to more inshore grounds to make better use of available sole quota. The level of plaice catches in these inshore grounds was such that the master did not consider it was practical or profitable to retain all plaice catches. To allow the vessel to continue fishing under a revised business plan the condition to land all plaice catches was removed and along with it the additional quota that was provided (in line with scientific observer data that gives a discard rate of 4.9%).

The low discard rate data for ICES area VIIde plaice is obtained exclusively from offshore sampling (Cefas personal communication, March 2012). There is therefore insufficient discard data on the inshore fishery in which discard rates may be considerably higher because of juvenile abundance. Vessels targeting sole in the inshore area may therefore have greater difficulty in selecting out plaice catches as they generally use a smaller mesh size to maximise sole catches. Plaice catches

from this fishery are likely to have a lower market value, which makes additional quota as an incentive to land all catches less attractive.

Although the vessels on the trial have demonstrated very low levels of discards and undersized catches of catch quota stocks it is considered that such results are far less likely from the inshore fishery. Masters have reported that they have avoided areas that they previously frequented where grounds hold more juvenile fish and this is considered to demonstrate the desired result in terms of juvenile avoidance under a catch quota scheme. Nevertheless, the inability to fish on inshore grounds in poor weather for example could represent an economic disadvantage if incentives to avoid them are insufficient.

In taking trials forward in 2013 it is important to try to obtain more data from the inshore fishery and specifically the question as to whether plaice can represent more of a choke species than in the offshore area. There is also a need to assess the impact of a discard ban in the context of quota uplift and fleet capacity, particularly for VIIe sole. The survival rates for species such as plaice should also be considered in the context of a landing obligation.

Choke species

The term 'choke species' has been widely used during the debate on proposals to implement a discard ban. The term is usually associated with mixed fisheries in which a pinch point may be reached at which quota for one or more species is exhausted before that for other key target species; at which point the fishery is at risk of closure if sufficient regulatory flexibility or additional quota opportunities are not available. Such a scenario not only risks closing a fishery but with it the inability to realise quota opportunities for key economic stocks.

A quota shortfall that gives rise to the choke species problem can be symptomatic of all the reasons for current discards where such discards are not practically avoidable or where relative quota shares are insufficient. Current quota shares among member states are based on historical landings, which are fixed through the EU policy of relative stability. In some fisheries it is becoming increasingly apparent that certain stocks pose the risk of a choke scenario where there is insufficient quota share at member state level.

CFP reform proposals include various mechanisms such as swaps between member states and a certain degree of quota flexibility to overcome this risk. It will be important therefore to determine how such measures can succeed and to what extend fleet capacity or changes to methods of fishing might be required.

The extent to which fishers have sought to ensure they can access sufficient quota for all species may be driven by a number of factors such as economics, availability and changes to fish stock abundance. As an example, haddock landings in the South West have increased considerably over recent years leading to high levels of discards of juveniles in small mesh fisheries and of mature fish for which quota is not available to all vessels.

Cod catches in the South West hake gill net fishery appears to represent a potential choke species, as there is insufficient quota within the UK, leading to the discarding

of mature marketable fish. This, along with other fisheries is being examined in more detail as part of a discard ban simulation trial being conducted by Cefas.

Plaice in the inshore beam trawl fishery and North Sea haddock and whiting are also potential choke species and it is envisaged that these stocks will be examined in more detail during 2013 trials. Quota North Sea plaice and western haddock was available for trials during 2012 but there was concern among potential participants that the cap on additional quota at 30% did not leave a sufficient buffer to mitigate the risk of having to stop fishing when quota for these stocks were exhausted.

Additional quota does not necessarily represent an incentive where the majority of discards are unmarketable or undersized. Examples include the North Sea sole fishery where the by-catch of small plaice may be unavoidable.

In the case of western waters haddock, as with cod, much of the discards are a result of quota restriction rather than market forces. Quota imbalance therefore needs to be addressed in order to prevent a choke scenario in such fisheries.

Compatibility of a discard ban with current technical regulations

Technical provisions aim to prevent the capture of juvenile fish by prescribing gear or area restrictions as well as to eliminate, as far as possible, certain species in certain areas. They may also restrict effort in certain areas to reduce juvenile catch mortality. Catch quota management is considered to host the potential benefit of flexibility from prescriptive control and technical provisions. The compatibility of a landing obligation with current regulations is discussed below.

Under the terms of the trial vessel crews were not allowed to discard certain stocks, rather, they were required to ensure the total catch was documented and landed regardless of size. Dispensations from relevant minimum size restrictions were therefore placed on board to allow this and clarify the requirement to inspecting officers.

The trial has shown relatively small quantities of undersized fish overall, with cod and plaice from mixed demersal fisheries comprising the majority. The data from the North Sea demersal fishery suggests that catches of undersized cod cannot be completely avoided with mesh sizes that allow sufficient target species to be retained.

For otter trawls used in the demersal fishery with codends of less than 110 mm, 6% of the overall cod catch was undersized. Similarly, in beam trawl fisheries, just less than 3% of the total plaice catch was undersized which suggests good levels of selectivity.

The current CFP proposals recommend a change from minimum landing sizes (MLS) to minimum conservation reference sizes (MCRS), below which fish should be landed but not available for human consumption markets. Currently, unmarketable catches include a component of fish above the minimum landing size, including species such as plaice and whiting. These may be discarded before being landed or may be withdrawn from markets where no sale is forthcoming.

The removal of minimum landing sizes for stocks subject to a discard ban is considered to be necessary. However, whether the MLS should be automatically replaced with a MCRS is perhaps debateable. Previous reviews of technical rules have seen the number of species with MLS reduce, such as lemon sole, on the basis that the minimum size for other species such as plaice would drive equivalent selectivity for lemon sole.

Where there is an illegal market for juvenile catches, such as for bass, a MCRS would provide a prohibition on marketing juveniles. The landing obligation however, may effectively legalise the retention on board and landing of juvenile fish subject to a discard ban, which would require adequate control and auditable traceability. The key consideration with regard to catch composition and the selectivity measures is whether a catch quota system would drive sufficient incentive to promote the use of selective gear.

Catch composition can be a relatively blunt tool as vessels can simply discard to remain within the prescribed catches in relation to mesh size. For this reason additional technical rules have evolved to minimise the capture of juveniles such as through the increased requirement for the use of square mesh panels, headline panels and separator grids. These measures relate primarily to gadoid species such as haddock and whiting.

Industry initiatives have demonstrated advances in selectivity that reduce unwanted catches, while at the same time improve fuel efficiency and fish quality. It is considered likely that a landing obligation would drive such incentives further where all catches count against quota and unwanted catches would represent additional cost to the operator in terms of fish handling, storage and disposal.

Results from the North Sea cod trial have shown that catch composition rules relating to cod would have resulted in discards of both marketable and undersized cod in order to remain within prescribed limits. One vessel operating under a dispensation from these rules demonstrated that the composition rules were met over a five-month period but not on some individual landings. In this scenario the vessel was not forced into regulatory discards, thus improving profitability.

Vessels in the South West beam trawl fishery have not encountered issues relating to catch composition as the majority of species caught fall within the 80 to 99 mm codend requirements. However they have not been subject to a discard ban on stocks such as haddock and cod, which could cause catch composition breaches if they were required to retain all catches. The catches of these species were not monitored but it is thought that, while there may be occasional catches, which exceed catch composition limits, they would represent a low proportion of catches over time.

Generally, technical provisions that currently give rise to discarding would need to be removed or revised under a landing obligation to prevent conflicting regulation. It is thought that vessels operating a fully documented fishery would have an incentive to avoid juvenile and unwanted catches and therefore require less prescriptive technical rules. It can be argued that this is dependent on the degree of confidence that discarding is no longer taking place; if part of the fleet is not monitored

effectively there may be a risk of operators paying little regard to selectivity and continue to discard.

Area restrictions

There may be fewer requirements to remove area restrictions such as those that relate to spawning areas or engine power limits inside 12 nautical miles, as these may not have a direct linkage to discarding activity. Other area restrictions are more complex in that they allow access provided certain provisions are adhered to. For example, the mackerel box legislation prescribed catch composition rules to prevent targeting of mackerel in the area. In order to maintain the purpose of these types of areas there is likely to be a need for a revision of the rules rather than complete removal.

A dynamic system of area closures is in place to protect against mortality of aggregations of juvenile and mature cod. The real time closure (RTC) system has been put in place as part of a package of measures linked to the multi-annual plan for the recovery of North Sea cod stocks. A catch quota system with full documentation of catch mortality may provide an automatic incentive to avoid aggregations of juvenile fish, although under the terms of the trial participant vessels have been required to adhere to RTC restrictions.

In the case of gill netters, masters have reported that they are effectively triggering mature cod RTCs because they are targeting aggregations of mature cod on wrecks. This can mean that they have to spread their fishing operations over a wider area in order to avoid the closed areas. It is considered that this element of RTC policy should be reviewed in terms of whether it is appropriate under a catch quota management system.

Effort limitation

Effort limitation schemes set up as part of multi-annual plans to improve the recovery of stocks can represent a significant cost to regulators. This includes the administration and monitoring of kilowatt-day caps at vessel and/or fleet level. Under a catch quota system where stock mortality is fully accounted for, the effort deployed in terms of kilowatt days could become less relevant as a means of capping fishing mortality. Where a fleet moves to a catch quota system there may be potential benefits in allowing for more operational flexibility and cost-saving in terms of effort administration.

Multi-annual plans for the recovery of some stocks also specify effort allocations against specified gear types and mesh sizes. This can create a perverse barrier to increased selectivity. For example, vessels operating in the Irish Sea (part of the cod recovery area) that do not have a track record of using mesh sizes of 100 mm or more are effectively prevented from using increased mesh sizes to avoid unwanted catches in the plaice fishery. This again supports the case for greater flexibility provided there is sufficient confidence in full catch documentation.

Monitoring and surveillance

Current regulations incorporate a 'high grading' ban, which prohibits the discarding of fish caught within quota limits and in compliance with technical rules such as those relating to catch composition corresponding to prescribed mesh sizes. Whether or

not discards may constitute high grading can be difficult to assess for a number of reasons.

Generally, discarding through high grading is carried out for commercial reasons whereby quota is preserved for high value catches or where quota might be freely available but with little or no economic return. Surface and air surveillance, vessel monitoring system (VMS) and catch reporting have limited ability to monitor for current high grading prohibitions. Therefore, it is not considered that these would be fully effective in monitoring a discard ban.

Traditional surveillance can be more effective in policing area restrictions but relies on effective interception of activity in the absence of remote or real time/retrospective evidence of gear deployment and catches.

EM sensor and CCTV data has been demonstrated to provide a high degree of resolution and transparency in the absence of a mandatory observer scheme, both for control purposes and for industry to demonstrate good practice. The system is not tamper-proof so it is recommended that a regulatory framework to ensure sufficient data integrity should be sufficiently robust, with appropriate sanctions applicable to poor data submission.

Species identification

2011 trials identified certain closely related species that can be difficult to differentiate from CCTV footage. These generally relate to flatfish species such as common sole/sand sole. The introduction of area VII megrim as a catch quota stock has shown that small megrim and scald fish can also be difficult to distinguish.

Obscuration by debris, benthos and other fish species can also hamper identification. A library of images has been developed to assist in differentiating such species.

Catches of sand sole are generally retained where fish are of a marketable size, in which case the problem can be overcome by a requirement to prohibit discards of sand sole as well as common sole. Scald fish are caught in lesser quantities and are not marketed; in this case it may be necessary to monitor overall discards of these two species and to compare findings with discard observer data to ensure megrim is not being discarded at significant levels.

Improved definition provided by digital cameras is expected to improve species identification although these as yet remain untested.

Transmission of real time sensor data and system health check

Over the 2012 trial period one participant vessel was fitted with a satellite modem in order to test the ability to transmit hourly system health check data and summary of sensor data. The data is viewed on a web based geographical user interface provided by Archipelago Marine Research Ltd (EM Interpret Lite).

Figure 32 shows a screen shot of the EM Lite software that provides hourly summaries of winch rotations, speed, position, and hard drive data storage remaining capacity as well as any outages of system functionality. This summary

data was deemed to be useful inasmuch as regular checks allowed analysts to monitor data quality on a daily basis if necessary. Throughout the trial a number of instances of control box power outages (from BETA prototype units) were observed, which allowed staff to seek external advice and be prepared to investigate and remedy earlier than would have otherwise happened.

Also, an analyst identified recording trigger failures (rotation sensor fault) within hours of a particular trip commencing. In this case the vessel was contacted immediately and advised to trigger recording manually (only 6 hauls data loss rather than the whole trip-82 hauls), with subsequent advice on cleaning and maintaining sensors offered once back in port.

Recent discussions with AMR have indicated that in future the satellite modems may be capable of transmitting stills images also, which in terms of monitoring marine protected areas (MPAs), closed areas and geo-fencing applications could be a highly effective tool, although this functionality is thought to be some way off at this time.

Figure 32: Archipelago Marine Research Ltd EM Lite software screenshot

Operational costs and logistics

Table 9 provides an estimate of the annual cost of EM monitoring per vessel of just over £9,000. The British Columbia hook and line catch monitoring programme by comparison is stated to cost $12,000 CDN (£7,600 GBP) per vessel (Stanley et al, 2011) over an active fleet of 200 vessels conducting 1,300 trips.

The Australian Fisheries Management Authority commissioned a discussion document on the benefits and costs of an EM programme compared to their existing observer programme (GSGislason & Associates Ltd, 2007), which estimated the cost per vessel over 9 fisheries at a figure of $11,864 AUD (£7,900 GBP).

The operational cost would be influenced by a number of parameters such as the level of audit required and the geographical spread of vessels in relation to

operational and technical support. Nevertheless, the estimate from this trial is considered to be a useful guide for planning purposes. The cost assumes that all equipment has a lifespan of three years although systems in use are now entering their fourth year. The cost is also considered to be an overestimate resulting from extended analysis time used to test different catch estimation methods. Assuming that analysis time can be brought to 3 hours per vessel or less and that equipment replacement is required at four-year intervals, it is estimated that annual costs could fall to around £8,000 per vessel.

Table 9: Estimated annual cost per vessel

REM/CCTV	Annual cost per vessel over 3 years
EM v4.5 system hardware and peripherals (cameras, cable sensors) initial cost of £8,000	£2,666
Annual software licence for EM record and EM interpret	£1,690
Installation costs based on initial installation cost of £2,100	£700
Estimates maintenance costs based on experience of costs incurred for operational and technical support	£450
Hard drives	£133
Analysis time based on average hours spent on analysis in 2012 at full economic cost of £45 per hour	£3,500
Total	£9,139

There is also a need to consider whether there are potential savings to be made by replacing or reducing current fisheries management methods such as effort regimes and monitoring and control, although in international examples quayside monitoring is considered to be a necessary integral part of an EM programme.

A range of methods to achieve fully documented fisheries (FDF) have been scoped through the English Fisheries Science Partnership (Dolder et al, 2013). This shows strong support from the fishing industry for improved data collection and accountability. Alternatives to EM may therefore be more appropriate and cost effective in some fisheries, particularly where proportionality to risks is taken into account. Improved data quality and quantity may present potential benefits in terms of improved stock assessment and industry accreditation.

The operational model for an EM programme is being considered as part of on-going work in 2013. A key aspect of this will be the relationship between fisheries administrations and the fleets that share fisheries across administration boundaries both within the UK and at member state level.

Currently trials using EM work on the basis that each fisheries administration carries out monitoring and support for its vessels, which requires that EM data be returned to the relevant administration for processing. Consideration could be given to reciprocal logistical arrangements (such as maintenance and hard drive exchange)

between competent authorities in cases where fleets tend to work remotely from the relevant administration.

Whatever model is used there is also the question of how to establish a level playing field with regard to audit levels and any sanctions that might result.

Equally important, will be consideration of operational and technical support. This aspect may be relatively straightforward where vessels are based in one location but it is likely to become a logistical problem for dispersed fleets. The EM system under trial is supported remotely by AMR and local arrangements have to be made to carry out on-board support either through outside contractors, in house expertise or a combination of both, as is the case for the MMO trials.

It is considered that cross-border working groups should be set up to consider these issues.

System functionality

Annex 1 summarises system faults that have been recorded at the interim stage of 2012. These are being considered with a view to minimising them where possible.

The EM system has been modified by AMR both in terms of analysis software improvements and in the provision of more effective on-board monitoring. The EM record on-board software 4.5 provides for more cameras with IP capability giving enhanced resolution with greater frame rates, which may help with issues such as species recognition. An internal UPS will now allow for a 'managed shutdown' in the event of power failure, which means video files are not corrupted as they could be in the 4.2 version.

Encryption capability, to be tested soon, will offer assurance of data protection. The ability to utilise larger storage disks will allow for longer intervals between hard drive exchanges, which may be appropriate for vessels operating remotely. A built in fish measuring facility should also allow for much faster fish length measurements with data loaded directly into an annotation file for subsequent exporting to database.

Conclusions

The results with a wider range of stocks have shown very low discard levels that are considered to be well within acceptable levels. Therefore, full catch mortality is considered to have been accounted for over the duration of the trial. The discard levels have been based on a random 10% audit of CCTV footage, which is considered to be sufficient for the applicable stocks as they are caught in reasonably consistent quantities.

Electronic monitoring is considered to provide an effective solution to discard monitoring where it is proportionate and cost effective to do so. It is considered to be more effective, in the absence of an observer programme, than conventional surveillance methods, which have hitherto largely failed to police the high grading ban currently in force.

Although fishing practices are becoming increasingly selective, some mixed fisheries still represent a challenge in the ability to avoid unwanted catches, particularly in demersal trawl fisheries. Where a discard ban is to be effectively monitored, it is important to understand the logistical and economic implications for industry and regulators.

Parameters such as discard survival rates and flexibility or changes to quota management, control and technical rules need to be carefully examined in the context of CFP reform implementation and further rolling out of EM as a monitoring tool. Collaboration with fishermen is therefore fundamental in the detailed implementation of policy for a landing obligation. While the implementation of a landing obligation is complex there are foreseeable benefits such as greater flexibility from prescriptive regulation, quota uplifts, transparency and traceability as well as enhanced scientific data collection.

CFP proposals as currently drafted, states the use of "CCTV, observers or other" (European Council, 2013) and this trial focuses on the use of electronic monitoring incorporating CCTV. Currently most EU fisheries do not have mandatory human observer monitoring schemes and catches are self-reported through a mandatory logbook system, which for larger vessels includes the electronic transmission of catch data to fisheries administrations.

Alternative methods of achieving fully documented fisheries are being examined by government and industry, such as through self sampling of total catches with verification through reference fleets using observers or cameras. Current MMO work programmes include the modelling of the UK fleet to assess which elements of the fleet would be best suited and appropriate for the use of CCTV monitoring.

A variety of faults with the remote monitoring equipment have occurred which have been reported by masters for rectification in port. Loss of data and resolution of footage has not given rise to undue concern although improvements are considered possible both in terms of reliability and adherence to the duty of care placed on vessel crews. It is clear that the correct environment for the control box, in terms of reliable power supply and ambient temperature, are important to prevent data loss.

Faults leading to loss of picture quality have included camera lens or visor displacement, water ingress into camera housing, condensation and dirty lens covers. Loss of sensor data has resulted from loss of functionality of winch rotation sensors, usually from dirty or displaced reflectors.

At an operational level the resource directed to EM analysis would need to be considered in the context of the overall control and surveillance program and how it is integrated into the general inspection regime. The system has been used in a number of countries globally, predominantly to replace or augment human observer programmes.

In the absence of a statutory observer programme EU fisheries rely on a self-reported logbook system, which for the larger vessels in the fleet require daily transmission of catch reports to the fisheries authorities. The results show potential for the EM system to provide a means of auditing catch records but there is

insufficient information at this stage to establish a performance scoring system. It is therefore recommended that an operational programme should focus a high level audit to ensure data integrity and to monitor for and quantify discard according to specific protocols.

Electronic monitoring has been met with mixed views by the industry and the main driver for participation has been the incentive of additional quota and days at sea. However, industry representatives, vessel owners and masters have engaged with the MMO and Defra during the course of the trial, recognising that such dialogue is essential in moving towards full documentation and accountability of catches. It is considered that benefits of moving to greater accountability for fishing mortality should be fully realised by the fishing industry.

Such benefits should include greater flexibility in fishing operations under a less prescriptive regulatory system for technical and control measures. It has been expressed that operating a level playing field among vessels sharing EU fisheries will be critical in the successful implementation of a fully documented catch quota system.

In comparison to EM it is considered that current surveillance methods represent relatively ineffective means of policing a discard ban, which already partly exists in the form of a ban on 'high-grading' where discards of legal and marketable fish occur to maximise financial return from the available quota.

The results of the trial relate predominantly to selective fisheries or those in which unavoidable unwanted by-catches have been mitigated as far as may be possible to remain profitable. While there is an assumption that current technical regulations can be relaxed to accommodate a discard ban, the risks of doing so need to be considered, particularly in mixed demersal fisheries which may be subject to a limited degree of monitoring for compliance.

There is also a need to consider whether there are potential savings to be made by replacing or reducing current fisheries management methods such as effort regimes and monitoring and control, although in international examples quayside monitoring is considered to be a necessary integral part of an EM programme. Exploring alternative approaches to fully documented fisheries (FDF) are on-going as part of an industry and fisheries science partnership initiative. Some alternative approaches to FDF may be more appropriate and cost effective in small-scale fisheries with large numbers of vessels. Potential for improved data quality and quantity may also present potential benefits in terms of improved stock assessment and industry accreditation.

Forward look

Further work is planned to examine the implications of potential choke species in mixed fisheries in the South West and the North Sea through further catch quota trials. This will include an evaluation of the impacts of a discard ban on species such as plaice in the southwest inshore area, western waters haddock and potentially North Sea haddock and whiting.

A separate work stream is also preparing for an operational EM programme from 2014 when it is currently expected that a discard ban will apply to pelagic stocks. It is therefore intended to evaluate logistical infrastructure needs and other important areas such as the adoption of a level playing field for discard ban implementation. This will include modelling the potential impacts of discard bans by fishery and fleet segment.

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Annex 1: System faults

Control box faults

Location	Description of fault	Associated data loss
North sea	Intermittent operation over period of 8 fishing trips. Subsequent issues on vessel led to diagnosis of insufficient power supply. Bench tested and deemed serviceable.	Estimate video/sensor data loss of 6 out of 77 hauls (7.8%) over a period covering 8 fishing trips.
North sea	Complete control box failure due to motherboard failure. Required repairs in Canada.	Box failed shortly after vessel sailed, resulting in total data loss from trip (5 days)
North sea	Intermittent operation over period of 3 fishing trips. Repairs not made earlier as description of fault unclear from vessel and was landing into foreign ports over the period. Again, this unit was thoroughly bench tested and deemed serviceable.	11 hauls (from a total number of hauls of 66 – 16.7%) lost over the period of 3 fishing trips.
Western Channel	Fault originally diagnosed by engineers as loose connection to power supply. Vessel sailed on subsequent trip, having completed and passed function test only to have control box fail early in trip. Box replaced. CPU fan on motherboard had failed, causing control box to overheat or shutdown. Local repair effected and unit bench tested and deemed to be serviceable.	As this fault was originally misdiagnosed, data loss was for 2 complete fishing trips, comprising of a total of 41 hauls in total.
Western Channel	Control box replaced as during routine software upgrade as (perhaps due to software issue) the process could not be completed.	Nil
Western Channel	Shortly after vessel sailed on first catch quota trials trip he reported screens had ‘frozen’. Upon return to port control box replaced. Subsequently returned to AMR for repairs (under warranty) relating to video capture card.	A full 5-day fishing trip was lost due to this fault.

Location	Description of fault	Associated data loss
Western Channel	BETA prototype unit shutting down intermittently. Fault was traced to events logs which suggested UPS unit was over-heating, causing system shutdown. Additional ventilation fans and grills fitted seemed to mitigate fault. Unit shipped back and replaced (under warranty)	Over a period of 5 fishing trips (covering approximately 2 months) 16 out of a total 278 hauls were corrupted due to this fault.
Western Channel	Control box failed as vessel changed over from shore-ship power supplies. Control box swapped and subsequently repaired under warranty by AMR.	No data lost, but vessel was delayed from sailing for approximately half a day.

Of the total 8 control box issues identified above, two are thought to be due to inconsistent power supplies, and another due to a software fault while undertaking routine software upgrade. A further two units were shipped back to AMR (under warranty) as they failed bench-tests before installation. These issues are thought to be related to vibration effects during shipping. Future trials should focus on either trialling the use of UPS units and/or connecting to alternate more robust power supplies.

Camera faults

Camera fault type	Number of occurrences	Reason
Sunshades or lenses moved after installation causing obscured or poor imagery	6	Installation errors, vibration
Loss of imagery due to loose BNC connections	3	Installation and/or vibration
Camera power supply failure	1	Unit failure
Camera power supply failure with moisture ingress	2	Breakdown of sealant, damage to composite cable adjacent to camera
Camera view altered	2	Camera straps/mounting loosened over time due to vibration. Moving joints in camera housing not secured (installation error)

In addition to these documented faults, imagery was sometimes observed to be poor due to failure of crew to keep camera domes clean and dry and bright sunlight on occasion.

Rotation sensor faults

Fault type	Number of occurrences	Resultant data loss
Sensor failure	2	Nil, rotation sensors were configured as secondary trigger. Sensor data still readable despite absence of rotation sensor data
Sensors or reflectors dirty, reflector damaged	3	1) A vessels system failed to reliably trigger recording as sensors/ reflectors were dirty. In this instance 7 out of 106 hauls over 5 trips were not recorded. 2) 1 reflector had fallen off and others were dirty, resulting in video trigger not working. Master noticed and triggered manual recording until repairs affected. 2 hauls of data lost. 3) As above, 6 out of 82 hauls lost.

Most of the data losses attributable to rotation sensor issues have been mitigated by re-configuring recording settings so they now no longer rely upon sensor activation. However, a timely audit of data as soon as it is received could identify such issues and repairs could be affected immediately.

Other faults

The only other faults reported over the trial period were two faulty keyboards, which were replaced by MMO staff. No issues were encountered with either GPS or pressure sensors.

	Component failure (returned to AMR for repairs)	Due to power supply issues (subsequently ran fine after bench testing)	Due to installation and/or maintenance issues
Pressure sensors	0%	0%	0%
GPS	0%	0%	0%
Rotation sensors	8%	-	12%
Cameras	1.3%	-	17%
Control boxes (n=27 deployments)	11.1%*	7.4%	7.4%
Control boxes (based on total (n=30) deployments)	10%	6.67%	6.67%

* Of the 3 units sent back to Canada for repairs, 2 failed within first 1 or 2 trips, which could indicate transit damage or vibration issues. Beta test unit issues not included in control box rates.

Annex 2: Application pack for participation in North Sea trials

Catch quota management with remote electronic monitoring system: North Sea stocks

Introduction and background

The Marine Management Organisation (MMO) is managing the Department for Environment, Food and Rural Affairs (Defra) commissioned Catch Quota Scheme (CQS) in 2012 in the North Sea.

This expanded trial follows on from the North Sea cod scheme run in England in 2010 and 2011. The trial will investigate how the use of catch quotas can further reduce discards across an expanded range of species in North Sea fisheries. The stocks that we aim to facilitate in 2012, subject to the outcome of the December fisheries negotiations are:

- cod
- haddock
- saithe
- plaice.

We would prefer expressions of interest for piloting more than one of these stocks at a time, so we can better understand how catch quotas could work in a mixed fishery.

Catch quotas are an alternative means of managing fisheries based on catch rather than landings quotas and have demonstrated their effectiveness at reducing discards and encouraging more selective fishing behaviour.

The project is expected to start in January 2012 and will end on 31 December 2012.

The main objectives of the project are to:

- further investigate the potential of catch quota management to reduce discard levels with a particular focus on how mixed fisheries will be affected
- investigate the potential of catch quota management to reduce fishing mortality rates
- provide evidence and experience from the scheme for the reform of the Common Fisheries Policy (CFP)
- provide further detailed evaluation of using catch quotas as a fishery management and discard reduction tool

- evaluate how a catch quota system would operate in a mixed fishery
- enhance our data collection to improve fisheries science and advice.

The main principles of the catch quota scheme are that:

a) all catch quota stocks caught shall count against quota
b) all catch quota stocks caught shall be retained on board and landed (no discards are permitted)
c) once a vessel's quota for catch quota stocks is reached, it must stop all fishing practices if sufficient quota cannot be secured or where incidental catches cannot be avoided
d) during the trial fishers will be responsible for recording all of their catches – remote electronic monitoring systems (REMs) will be used to verify this data.

Additional quota

At the 2012 total allowable catches (TAC) and quota negotiations the UK will be negotiating for an additional percentage of quota for a range of species specifically for use in this catch quota trial. In 2011 for example, this represented at additional 12 per cent of quota for North Sea cod. This quota was available for use in the scheme and in a separate scheme running in Scotland. **The stocks and amount of additional quota available for catch quota schemes in 2012 will depend on the outcome of December Council. Applications may be withdrawn if terms offered to applicants are not agreeable following those negotiations.**

Additional quota will be allocated to vessels participating in this scheme based on **75 per cent** of what might typically be discarded from the current landings based quota regime. Under this catch quota scheme you are therefore asked to bid for up to the amount which you see regularly discarded from your vessel, bearing in mind that you are limited to a maximum of 75 per cent of the discard rate (see table 1 below).

Table 1: North Sea stocks for which a CQS scheme is proposed and the provisional percentage discard rates on which additional quota which will be based to participate (subject to 2012 TAC negotiations)

	TR1		TR2		BT1		BT2		Static Gear	
	Discard rate	75% of discard rate	Discard rate	75% of discard rate	Discard rate	75% of discard rate	Discard rate	75% of discard rate	Discard rate	75% of discard rate
Cod	38%	28%	60%	45%	19%	14%	19%	14%	2%	2%
Plaice	10%	7%	40%	30%	--	--	48%	36%	62%	47%
Saithe	5%	4%	12%	9%	25%	19%	--	--	--	--
Haddock	15%	11%	64%	48%	--	--	15%	11%	--	--

We are also considering a catch quota trial on North Sea lemon sole and witch, if you are interested in this stock please contact ukcatchquota@defra.gsi.gov.uk.

Definition of gear codes:

- TR1 equal to or larger than 100 mm
- TR2 equal to or larger than 70 mm and less than 100 mm

- BT1 equal to or larger than 120 mm
- BT2 equal to or larger than 80 mm and less than 120 mm
- Static Gears: gill nets, entangling nets (GN), longlines (LL).

The additional quota available will be allocated on the basis of a vessel's track history of landings in 2011. Actual additional quota receivable will be based on a pro-rata allocation for the total monthly duration of the trial.

Applicants are asked to submit a bid up to the percentages outlined in table 1 required to operate catch quota management. This bid should be based on what you have observed your vessel discarding for the stock for which you are bidding for catch quota, the gear type in use and a plan to reduce fishing mortality.

Please note that all catches of CQS stocks (including undersized fish) will count against the vessel's quota and must be landed. No discards of those stocks are permitted.

Days at Sea

Participating vessels may be offered additional days at sea to allow more flexible fishing operations when catching their quotas. The amount of days made available will depend upon the overall constraints of the 2012-2013 Days at Sea regime.

Applicants are requested to provide an estimate of how many additional days they consider necessary to allow fishing to continue for the project period. Vessels will receive a pro-rata allocation for the total monthly duration of the trial. Additional days at sea will be notified to participants prior to starting the scheme.

Selection process and criteria for participation

Vessels will be selected to participate on the basis of the criteria set out below.

Mandatory criteria

Vessels wishing to participate in this trial must meet the following criteria:

- Vessels must be English-administered at an MMO coastal office and be a member of a producer organisation.
- The skipper must make himself and the vessel available at a UK port (where possible) for a period of up to three days prior to the start of the scheme to allow installation of the monitoring systems and for one day after completion of the trial for the equipment to be removed.
- The vessel must satisfy accommodation standards as specified in the terms and conditions. The vessel must have a current Maritime and Coastguard Agency (MCA) safety certificate and be willing and able to take an observer to sea when required as part of this project.
- All vessels must have adequate insurance cover for the vessel and for personnel on board. The insurance must also include cover for the REM equipment up to the value of £12,000.

- A vessel engaged in pair trawl activities shall only be eligible for the scheme if both vessels are signed up to the scheme.
- Vessels must be compliant with mandatory electronic reporting requirements.

Please see the terms and conditions of the scheme for full details.

Selection criteria

Applicants who meet the mandatory criteria will be sifted and places allocated on the scheme against how well they are judged to meet the following criteria:

- A clear indication, in the form of a Fishing Plan, on how fishing operations will be managed, in order to:
    - reduce fishing mortality
    - reduce catches of undersized fish of all species
    - avoid catches of juvenile fish
    - maximise quota and effort allocations.
- A clear indication of how undersized fish will be disposed of, for example information on which fishmeal processor or whether it will be offered for use as bait.

Other considerations

Where appropriate, priority will be given to applicants offering to undertake a CQ trial on two or more species in a mixed fishery.

Defra and MMO reserve the right to choose those individuals that they consider to be fit and proper persons for participation in the scheme. Defra and MMO require applicants to provide any information they consider relevant to this decision.

Examples of information that may be contained in such a statement are:

- details as to whether or not the applicant has outstanding county court judgments
- whether the applicant has been declared bankrupt within the past 12 months
- whether the applicant has complied with fisheries legislation in the past 12 months.

In making their decision Defra and MMO will consider all relevant information available.

Submission of the application

The application form attached below must be completed and submitted, by electronic copy to ukcatchquota@defra.gsi.gov.uk or by hard copy to:

Catch Quota Team – Western Waters
MMO District office Fish Quay
The Fish Quay, Sutton Harbour, Plymouth, Devon, PL4 0LH

Queries about the application

Clarification of the application requirements can be given. Please email queries to ukcatchquota@defra.gsi.gov.uk.

Timetable

Applications must be received by **12.00 noon** on **Monday 12 December 2011**. Applicants will be informed of the results as soon as possible.

December Council negotiations are being held on the 15 and 16 of December. Applicants reserve the right to withdraw their application if the negotiations do not provide satisfactory terms for participation.

Application form

Catch quota management with remote electronic monitoring system: North Sea stocks

Please use this to submit your application – failure to provide the requested information may result in disqualification of the application.

1) Name of applicant (in capitals)

Name:

2) Address and contact details (in capitals)

Address for contacting over this application:

Daytime phone numbers and mobile number:

Email address:

3) Vessel name and skipper

Vessel name:

Vessel registration number:

Skipper:

4) Gear type

Please mark which gear types are intended to be used by your vessel during 2012 in the box below.

TR1	TR2	BT1	BT2	Long-line	Gill net

5) Additional quota

Additional quota will be allocated to vessels participating in this scheme based on the average discard rate for each gear type.

Taking into account the maximum additional quota which we can offer (no more than 75 per cent of the discard rate for each species and gear type, see table 1), please enter your bid for how much additional quota you need to participate in a catch-quota trial.

For example, the maximum amount of VII anglerfish quota which we can offer for static gear would be based on a 7 per cent discard rate, so you will want to enter a figure between 0 and 7 per cent in the table below, based on your estimation of how much you might be discarding.

Stock	Gear you will use	Your bid
North Sea cod	TR1	
	TR2	
	BT1 or BT2	
	Gill net or long line	
North Sea plaice	TR1	
	TR2	
	BT1 or BT2	
	Gill net or long line	
North Sea saithe	TR1	
	TR2	
	BT1 or BT2	
	Gill net or long line	
North Sea haddock	TR1	
	TR2	
	BT1 or BT2	
	Gill net or long line	
North Sea lemon sole and witch	TR1	
	TR2	
	BT1 or BT2	
	Gill net or long line	

6) Days at Sea

Applicants are requested to provide an estimate of how many additional days they consider necessary to allow fishing to continue for the project period. Vessels will receive a pro rata allocation for the total monthly duration of the trial. Additional days at sea will be notified to participants prior to starting the scheme.

Please provide an estimate of how many additional days you consider necessary to allow fishing to continue for the project period, explaining how you have arrived at this conclusion:

Number of days: ……..

Explanation:

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(please continue on a separate page if necessary)

7) Other considerations

Please provide details of any outstanding court judgments, whether or not you have been declared bankrupt within the last 12 months, compliance with fisheries legislation in the past 12 months and any factors relating to these matters.

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(please continue on a separate page if necessary)

8) Membership of fish producer organisation

The vessel must belong to a fish producer organisation.

I confirm that the vessel is a member of a fish producer organisation (delete as appropriate).

Yes/No

The producer organisation which the vessel is a member of is:

9) Electrical supply

The vessel must have a reliable electricity supply.

I confirm that the vessel has a reliable electricity supply (delete as appropriate).

Yes/No

On-board voltage is **[ ]** volts.

Please state below your preferred electrical contractor who will fix any problems relating to the REM equipment on your vessel:

.....

The MMO will cross-assess the contractor you nominate for competency to undertake the work.

10) Observer capacity

The vessel must have the capacity to carry an observer and the facilities to enable an observer to remain on board overnight if required.

I confirm that the vessel has the capacity to carry an observer and the facilities to enable an observer to remain on board overnight if required (delete as appropriate).

Yes/No

11) Availability for camera fitting or removal

a) The vessel must be available from December 2011 for up to three days to ascertain its suitability and to install the equipment. These days will be arranged at a mutually convenient time for the applicant and MMO.

I confirm that the vessel will be available for three days at a mutually agreed time (delete as appropriate).

Yes/No

b) The vessel must be available for one day between January and March 2013 for the equipment to be removed. This will be arranged for a mutually convenient day between the applicant and MMO.

I confirm that the vessel will be available for one day at a mutually agreed time between January and March 2013 (delete as appropriate).

Yes/No

12) Certification

Applications for vessels 10 metres length overall (LOA) to less than 15 metres LOA must include:

- A **copy** of a valid Maritime and Coastguard Agency (MCA) Fishing Vessel Decal Certificate issued by an appointed MCA surveyor after inspection to ascertain the vessel's general seaworthiness and compliance with the Small Fishing Vessels Code of Practice for Fishing Vessels under 15 metres LOA, MSN 1813.

Applications for vessels 15 metres LOA to less than 24 metres registered length must include:

- A **copy** of a valid MCA Safety Certificate issued by an appointed MCA surveyor after inspection to ascertain the vessel's general seaworthiness and compliance with the Code of Safe Working Practice for 15 metres (LOA) to less than 24 metres (L) Fishing Vessels.

Applications for vessels over 24m LOA must include:

- A **copy** of a valid International Fishing Vessel certificate (Certificate of Compliance) issued by an appointed MCA/ or Lloyds surveyor after inspection.

13) Insurance

All vessels must have adequate insurance cover for the vessel and for personnel on board. (You may wish to detail your P&I and personnel insurance and the limits of financial liability on each.) The insurance must include cover for the REM equipment up to the value of £12,000.

I enclose a copy of the current vessel insurance (delete as appropriate).

Yes/No

I confirm that additional insurance cover for the REM equipment will be arranged prior to the start of the trial and a copy of the cover note sent to MMO (delete as appropriate).

Yes/No

14) Fishing plan

A clear indication should be provided as to how fishing operations will be managed, including the use of selective gears and changing fishing time or location in order to avoid cod.

A fishing plan must be submitted with the application and will be a significant part of the evaluation. A separate template is available at the end of this form (Annex A).

15) Disposal of undersized fish

Participants are required to dispose of undersized fish by sending them for processing into fishmeal or offering as bait to static gear operators. Please describe how you will fulfil this obligation.

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(please continue on a separate page if necessary)

Signed:

Date: