



Catch Quota Trials 2011

Interim report: November 2011



Contents

Executive summary.....	1
Introduction	2
Methodology	3
Legislative basis	3
Selection of vessels	3
Quota management.....	3
Equipment and analysis.....	4
Interim results	5
Data collection and analysis	5
Species identification	6
Reliability of REM equipment.....	6
Catch estimation	7
Observed discards.....	9
Undersized fish	11
Discussion.....	11
Reduction of discards	12
Quantifying retained catch	12
Enforcing a discard ban	13
Monitoring and surveillance	13
Potential implications for future management	14
Effort restrictions.....	14
Catch composition rules	14
Quota imbalance.....	14
Industry engagement and views	15
Conclusion	15
Key findings	15
Annex 1: Participating vessels – North Sea and proposed cod selectivity/avoidance measures ...	17
Annex 2: Participating vessels – Western Channel and proposed selectivity measures.....	18
Annex 3: Terms and conditions.....	19
Remote electronic monitoring onboard English fishing vessels	24

Executive summary

The Marine Management Organisation (MMO) has been commissioned by the Department for Environment, Food and Rural Affairs (Defra) to operate the English fully documented 'catch quota' scheme in 2011. The key principle of a catch quota system is that all catches must be retained, landed and counted against quota. A prohibition of discards for key species provides a strong incentive to fishers to fish selectively and avoid juvenile fish. The project is being run in tandem with other fully documented fisheries projects across Europe and builds upon the UK and European pilots in 2010.

The English scheme started in March 2011. There are 12 English vessels participating for North Sea cod and 3 vessels for International Council for the Exploration of the Seas (ICES) Area VIIe sole. One vessel is voluntarily piloting catch quota for more than one stock (sole, plaice and anglerfish) in the Western Channel. Additional quota was made available to vessels piloting cod and sole in the way prescribed by Council Regulation (EU) 57/2011. Additional quota for the single vessel trial on plaice and anglerfish was made available through domestic scientific derogation (Council Regulation (EC) 1224/2009).

The main aims of the 2011 project are to test the operational management and enforceability of remote electronic monitoring (REM) and CCTV as a means of verifying catch documentation and discard levels across a range of species and fisheries.

Minimal quantities of discards (0.25 per cent of total catches) have been observed for discard-prohibited species during catch sorting operations, where some small fish go unnoticed by crew. This demonstrates the efficacy of the system as a means of reducing and monitoring discards. Total catch mortality for participating vessels has therefore been fixed.

Overall catches of undersized fish have been low and indicative of effective selectivity measures, however, this data has not been analysed and compared to non-participating vessels.

The REM/CCTV system has proven largely reliable, although it is evident that operating the system on a larger scale will require an adequate maintenance infrastructure, for which outsourced technical support is likely to be required.

Accuracy in the estimating of catches by both observers and fishing vessel masters on each fishing operation is subject to variation depending on the method of sorting and volume of catches. It is considered that alternative methods of quantifying catches should be explored in order to provide greater confidence in catch verification and to reduce the time taken to analyse CCTV footage. The system is effective in monitoring the discards of key species although some closely related species can be difficult to differentiate (such as Dover sole and sand sole).

Valuable information has so far been collected on the use of REM/CCTV to monitor catches of a range of species. There is, though, a need to further understand the impacts of the catch quota principle in a mixed fishery. However, the potential for future trials will be heavily influenced by EU Council and EU/Norway negotiations. Furthermore, we consider that artificial caps on the available additional quota (such as 30 per cent) for catch quotas could act as a barrier to fishermen participating for other species in potential future schemes where the discard rate for a stock is higher than the regulatory cap (for example, North Sea plaice).

Introduction

Current quota management and technical regulations place restrictions on what fishermen land. As a consequence fishermen often have to discard part of their catches in order to remain within the rules. There is often little incentive or opportunity for fishermen to acquire sufficient quota for all species in a mixed fishery and to increase the selectivity of their gear in order to avoid discarding. In many cases there is an imbalance between available quotas amongst stocks in mixed fisheries.

Catch quota management is an alternative way to manage fisheries. It shifts the focus away from quotas for fish that are landed, towards accounting for all catches through full documentation of vessel fishing activities. CCTV linked to a remote electronic monitoring (REM) system can be used to verify that catches taken on board a vessel are correctly documented and not subsequently discarded. With discarding accounted for, quotas can be based on what is caught rather than what is landed. This gives a greater confidence in fishing mortality levels and minimises discarding.

The 2010 pilots of catch quota management for North Sea cod provided evidence that catch quota management can reduce discards and encourage fishermen to fish more selectively. It also showed that the REM technology could potentially work to manage a catch quota scheme for cod. However, further evidence is needed on how this system could be implemented at a larger scale (more vessels) and for other fisheries. This evidence will also be essential to inform Europe where fully documented catches quotas could be an appropriate management measure under a reformed Common Fisheries Policy (CFP).

The Marine Management Organisation (MMO) has been commissioned by the Department for Environment, Food and Rural Affairs (Defra) to operate the English fully documented catch quota scheme in 2011. The project is being run in tandem with other fully documented fisheries projects across Europe and builds upon the UK and European pilots in 2010.

Twelve vessels in the North Sea and three vessels in the Western Channel were selected to take part in catch quota trials in 2011 using a variety of gear types and methods for improved selectivity. Additional quota for International Council for the Exploration of the Seas (ICES) Area IV (North Sea) cod and ICES Area VIIe (Western Channel) Dover sole were made available to participants to allow the landing of catches that might otherwise have been discarded. One Western Channel vessel is also participating in respect of area VII angler and VII d and e plaice, which will provide additional evidence of the implications of a multi-species approach.

Though we consider effort restrictions are unnecessary as total catch mortality is fixed, the current cod recovery regulations do not allow for effort exemption for participating vessels. Therefore, 50 additional days at sea were awarded to North Sea vessels to enable greater operational flexibility.

The pilot project for 2011 has the following key objectives.

- To assist and progress Defra objectives to reduce discards.
- To trial operational catch quota management in fully documented fisheries in the North Sea and Western Channel in accordance with Article 7 of Council Regulation (EU) 57/2011.
- To test enforceability of a catch quota system in the context of North Sea and South West mixed fisheries.
- To inform Defra policy on the operational use of a catch quota system particularly with regard to the use of REM and CCTV as a monitoring tool.

It is envisaged that a catch quota system could deliver the following benefits:

- Reduce discards and reduce fishing mortality by encouraging fishermen to fish more selectively whilst at the same time land more of what they catch.
- Provide improved scientific data in order to make better stock assessments.
- Provide an economic driver to optimise catch selectivity, as all fish counts against quota, including juvenile fish.
- Provide greater flexibility for fishers in terms of technical measures and effort restrictions.

Methodology

Legislative basis

The trial is being run in accordance with Article 7 of Council Regulation (EU) 57/2011. Specifically this states that vessels participating in fully documented fisheries, including the use of CCTV coverage, will be able to secure additional quota for certain stocks (North Sea cod and Western Channel Sole for the purposes of this trial). The regulation requires that participating vessels do not discard any fish from these stocks regardless of size and that all catches count against quota. The quantity of additional quota allocated to an individual vessel must not be more than 30 per cent of its allocation and must represent no more than 75 per cent of the expected discard rate for the gear in use.

Once the quota for catch-quota species is exhausted the vessel must cease fishing by any means that risks further catches of the stock. The additional quota coupled with the cap on catches provides the incentive for fishermen to avoid catching juvenile and low value fish by fishing more responsibly, through improved gear selectivity, spatial and temporal avoidance and diversification to alternative stocks, or non-fishing activity.

Selection of vessels

Vessel owners were invited to apply to take part in the pilot and were selected on key criteria such as the use of selective fishing gear and the provision of a fishing plan which demonstrated the ability to avoid the capture of juvenile catch quota species. They were also invited to bid for additional quota up to the ceilings provided for in Council Regulation (EU) 57/2011. Details of the participating vessels along with a summary of their proposed selectivity measures are included in Annex 1 and 2.

There was sufficient additional cod quota for all 12 North Sea applicants and all were accepted onto the scheme. Similarly, all three applicants were accepted onto the Western Channel sole pilot.

Terms and conditions (Annex 3) apply to participating vessels which iterate the requirements of Article 7 of the Council Regulation and also set out a duty of care placing an obligation on vessel masters to ensure the REM equipment is fully operational at all times.

Quota management

Additional quota is drawn down as a percentage of each landing to ensure that it is taken in the correct proportion to overall catches. This ensures consistency across all fishing operations and prevents the extra quota from being deployed in response to market demands. The uptake of additional quota is monitored by the MMO and reported to the producer organisation to which

participating vessels belong to. The additional quota is not a commodity that can be traded to vessels not participating in the scheme. Table 1 outlines the range of gear types involved in the scheme.

Plaice, anglerfish and sole are caught by beam trawls throughout the year subject to seasonal fishery variation. Vessels participating in the North Sea may take cod as a by-catch or as a target species depending on the fishery.

Equipment and analysis

Vessels are fitted with remote electronic monitoring (REM) systems developed by Archipelago Marine Research Ltd.Ca. The system captures CCTV imagery from four cameras, time, vessel position, vessel speed, winch rotation speed and winch hydraulic pressure.

Analysis software allows observers ashore to monitor CCTV footage to identify gear hauling events and fish sorting operations using Archipelago analysis software.

Catches are estimated from a random 10 per cent selection of hauls and compared to the master's documented estimates. Masters are required to keep statutory logbooks and are also required to keep and submit records of catches of catch-quota species for each fishing operation, recording undersized fish separately. Undersized catch-quota species must be retained, landed and counted against quota but not offered for sale. Undersized fish can be supplied for bait or to fishmeal plants and documentation showing the weight of fish must be submitted for quota uptake purposes. In the case of static gear vessels where hauling operations are continuous, masters are required to keep records of catches on a daily basis and analysis is carried out at a rate of 10 per cent of fishing days.

Fishing operations are selected on a random basis for analysis which comprises checks for discards of catch quota species, estimation of retained catch of catch quota species and estimation of undersized catch quota species.

Data has been evaluated from the following sources:

- logbook data for vessels over 10 metres, either electronic, paper or both
- haul-by-haul logbook data available from vessels working in the Norwegian sector
- landing declarations from vessels over 10 metres
- sales notes by species and grade for all vessels
- masters' haul-by-haul records of catch quota species
- REM and CCTV data for all trips, including winch activity, vessel position and speed and CCTV footage.

Table 1: Gear types grouped for data analysis

Gear type	Metier	Species subject to catch quota terms
Towed	Otter trawl	North Sea cod (targeted and non-targeted fisheries)
Towed	Pair trawl	North Sea cod
Towed	Beam trawl	Western Channel sole
Towed	Beam trawl	Western Channel sole, plaice, anglerfish*
Static	Fixed gill net	North Sea cod
Static	Long line	North Sea cod

*Increased quota for Area VIId and e plaice and Area VII anglerfish made available through UK domestic scientific derogation.

Interim results

Data collection and analysis

The pilot aims to carry out analysis at a rate of 10 per cent of fishing operations. The achieved analysis rates for each gear type are outlined in Table 2 and the time taken to carry out analysis across the range of gear types and species is provided in Table 3.

Table 2: Analysis coverage for each gear metier

Gear type	Number of trips	Number of hauls fished	Number of hauls sampled	Percentage of hauls analysed
Beam trawl	22	1538	153	9.9
Beam trawl (three species)	9	565	49	8.7
Long line	3	29	3	10.3
Gill net	5	42	5	11.9
Otter trawl	68	1066	107	10.0
Pair trawl	14	138	14	10.1
Totals	121	3378	331	9.8

Table 3: Time taken to analyse hauls and trips

Gear type	Number of trips	Number of hauls sampled	Analysis time (hours)	Average analysis time per haul (hours)	Average analysis time per trip (hours)
Beam trawl	22	153	73.25	0.48	3.3
Beam trawl (three species)	9	49	51	1.04	5.6
Long line	3	3	12.25	4.08	4.1
Gill net	5	5	26.5	5.30	5.3
Otter trawl	68	107	233.09	2.18	3.4
Pair trawl	14	14	45.5	3.25	3.25
Totals	121	331	441.59	1.3	4.2

The time taken to analyse data varies across the range of gear types from under one hour to in excess of five hours. For static gear vessels (long liners and netters) each fishing day is treated as one hauling event. The analysis time per trip is more consistent with an average time of 4.2 hours. The vessels requiring the most analysis time are the netters and the beam trawler being monitored for three species.

There are a number of variables which dictate the time taken to analyse a single vessel voyage apart from the number of species being monitored. Haul frequency and time duration of sorting operations are key factors but there are also numerous factors which can affect the speed with which observers can estimate catches such as the quantity of other species and debris as well as the total volume of the catch.

Species identification

Resolution of CCTV footage has generally been of a high enough quality to distinguish between key species. Some closely-related species can be difficult to differentiate; a notable example is the differentiation between Dover sole and sand sole, particularly where specimens are partially obscured. Sand sole is generally caught in small quantities and the proportion of sand sole in the catch can be verified on landing.

Reliability of REM equipment

The REM systems have proven to be generally reliable and all faults have been rectified either at sea or immediately on return to port. None of the participating vessels have been required to delay departure from port while carrying out fault rectification. A summary of detected faults is set out in Table 4.

Table 4: Summarising faults reported, data loss and remedial actions

Control box failures	Camera failures	Rotation sensor failures	Pressure sensor or GPS failures	Lost data	Lost fishing days	Man hours to rectify (including travel)
-	2	-	-	Nil-camera faults occurred while vessel on guard work	0	8
1	-	2	-	Nil	0	18
-	-	-	-	Nil	0	-
1	1	1	-	Intermittent, non-critical loss from 1 camera	0	15
-	-	-	-	Nil	0	-
-	2	1	-	1 camera view for 12 fishing days – non-critical	0	13
0	1	-	-	1 camera view for 1 fishing day – non-critical	0	2
0	1	1	-	No corrupt video encountered during routine analysis. Rotation sensor failure non critical	0	2
0	-	-	-	Nil	0	-
0	-	-	-	Nil	0	-
0	-	-	-	Nil	0	-
0	-	1	-	Nil	0	-
0	-	-	-	Nil	0	-
0	-	-	-	Nil	0	-
1	-	1	1 (GPS)	Nil, intermittent short term fault. Poor image from overview camera, non critical	0	2.5

Catch estimation

A range of methods for estimating catches has been employed according to the type of sorting operation, volume of catch and relative volume of catch quota species. For example, for assessing

catches of sole on beam trawlers it is possible to carry out a count during the gutting process and an estimation of weight at the end of the sorting operation. Estimating both total weight and count can provide greater confidence in observed catches but it should be stressed that CCTV footage can only be used to estimate catches in terms of weight.

Vessel masters are required to estimate catches for each haul for towed gear and for each day for static gear. It is not prescribed how they should do this and there is no specific requirement to weigh the catch after each haul. Where catches per haul are small, such as beam trawl catches for sole, crew have been observed to weigh the catch on occasion as a means of quality assurance. Similarly, observers of CCTV footage are only able to estimate catches.

Tables 5 and 6 show that there can be a significant variation between observer and master estimates of marketable and undersized retained catches. The level of agreement (+/- 10 per cent) is clearly dependent on the information gathered during the sorting operation, for example the master may rely on a crewman's estimate by sight on each haul or there may be a quantified box count made. Generally, the results demonstrate a variable degree of subjectivity on catch estimation which is heavily influenced by the type of catch, gear and sorting operation.

Table 5: Marketable segment of catch

Gear type	Observer less than master		Observer = master (+/-10 per cent)		Observer greater than master	
	Number of hauls	Percentage of hauls	Number of hauls	Percentage of hauls	Number of hauls	Percentage of hauls
Beam trawl	27	19	70	48	48	33
Long line	0	0	3	100	0	0
Beam trawl (three species)	44	30	57	39	44	30
Gill net	1	20	4	80	0	0
Otter trawl	21	20	41	38	45	42
Pair trawl	2	14	10	71	2	14
Total	95	23	185	44	139	33

Table 6: Undersize and damaged segment of catch

Gear type	Observer less than master		Observer = master (+/-10 per cent)		Observer greater than master	
	Number of hauls	Percentage of hauls	Number of hauls	Percentage of hauls	Number of hauls	Percentage of hauls
Beam trawl	7	5	135	93	3	2
Long line	0	0	3	100	0	0
Beam trawl (three species)	14	10	124	86	7	5
Gill nets	1	20	3	60	1	20
Otter trawl	20	19	43	40	44	41
Pair trawl	9	64	3	21	2	14
Grand total	51	12	311	74	57	14

Although the data collated to date reflects only three days fishing for the long line vessel it is evident that there is a high degree of correlation between estimated catches (both observer and master) and landed weights. The observer estimation in the case of the long line vessel is aided

by the fact that the number of fish can be counted and the boxing of fish, during the catching and grading operations, can be monitored. The observer is therefore able to make a precise box count and to consider the declared box weight in relation to the estimated size of fish being caught.

Observers have also been able to carry out box counts during the sorting operation on some otter trawl vessels or counts of baskets of fish delivered to the fish room which also provide a greater confidence in estimated weights.

Catch estimation is considerably more subjective for both very small quantities such as partially filled baskets and for very large volumes which can only be observed en masse on sorting equipment. Figure 1 below is an example of the CCTV imagery that can be used to assess catches.

Figure 1: Example of observer view of sole sorting operation



Observed discards

Council Regulation (EU) 57/2011 requires that participating vessels must retain all catches of stocks for which extra allocation has been granted. It is therefore important to assess the efficiency with which observers can identify discards or verify that no discarding has taken place.

Vessels engaged in the trials are equipped with sorting conveyors or tables that lead to a discard chute. Fish which enter the discard chute or are manually thrown overboard are recorded as discards. Table 7 provides a summary of observer assessment as to how confident they are in being able to monitor for discards. Observers apply a confidence rating where:

- good reflects high confidence in the ability to observe any discarding
- medium where there is a potential for discards to go unobserved, this score being applied on occasions where image resolution is reduced, that is in situations where there is glare from sunlight
- poor rating where there may be fish obscured by other fish, debris or benthos, or where image resolution has been significantly reduced.

The highest level of 'poor' scoring was found in the trawl categories for cod. This stems largely from sorting operations involving large volumes of fish and in cases where there are large quantities of mixed species and benthos within which incidents of discards could go unobserved. This is in contrast to the static gear fisheries where there were no 'poor' scores given.

Observations from beam trawlers suggest a high degree of confidence in being able to monitor for discards of sole species in general although there is less confidence in identifying specific species, particularly in distinguishing between sand sole and Dover sole.

Table 7: Observer confidence in discard monitoring

Species	Gear type	Catch segment	Number of hauls*	Percentage good	Percentage medium	Percentage poor
Cod	Long line	Discarded	3	33	67	0
Cod	Nets	Discarded	5	60	40	0
Cod	Otter	Discarded	107	60	29	11
Cod	Pair	Discarded	14	36	50	14
Anglerfish	Beam trawl	Discarded	49	100	0	0
Plaice	Beam trawl	Discarded	49	90	8	2
Sole	Beam trawl	Discarded	47	85	13	2
Sole	Beam	Discarded	145	77	17	6

*Number of hauls where the species was encountered and analysed

Monitoring has revealed very low levels of discarding resulting from fish not being picked off sorting conveyors before they enter the discard chute. Observers have noted estimates of discards on sampled hauls which are summarised in Table 8. Although such discards are not allowed under the terms of the scheme the evidence suggest they are at a de minimis level.

Table 8: Observed discards

Species	Estimated discards (kg)	Total catch for observed hauls (from haul documentation) (kg)	Percentage discarded
Cod	95	29,225	0.3
Sole	4	1,762	0.2
Anglerfish	7	1,552	0.4
Plaice	1	771	0.1

Table 9 shows the comparison of total haul records with logbook records and landed weights. The logbook records for sole are more accurate when measured against landed weight than the total of the haul records. This appears to reflect the greater accuracy of assessing weight through box counts than through an estimation of the catch after each haul. Haul-by-haul catch documentation has been incomplete on a small number of occasions and this has added to the level of discrepancy. The estimates for plaice and anglerfish do not show a similar trend but a variable accuracy of estimation plus or minus approximately 10 per cent. The accuracy of documenting catch from the long line fishery is likely to reflect the method of sorting and boxing, and correlates with the higher confidence in observer estimation.

Table 9: Comparison of vessel documentation with landed weights (all weights in live weight equivalent)

Gear type	Species	Haul by haul record weight (kg)	Landed weight (kg)	Logbook weight (kg)	Haul-by-haul total as percentage of landed weight	Logbook weight as percentage of landed weight
Beam trawl	Sole	15,022	16,242	16,031	93	99
Beam trawl	Anglerfish	17,414	19,647	17,304	89	88
Beam trawl	Plaice	10,820	9,979	8,973	108	90
Long line	Cod	15,623	15,817	15,659	99	99
Nets	Cod	36,725	39,152	38,329	94	98
Otter	Cod	180,074	189,785	183,548	95	97
Pair	Cod	49,033	50,760	53,526	97	105

Undersized fish

Table 10 shows the undersized catch as a proportion of total catch across the gear meters. Anglerfish is not included in the table as it is not subject to a minimum landing size. Catches from otter trawls show a higher proportion of undersized fish (4.6 per cent), however this category includes both 120 mm and greater cod end fisheries targeting cod and haddock as well as smaller mesh cod ends used in plaice and nephrops fisheries. The data will be broken down to separate these fisheries in the final report. The undersized proportion for the pair trawl category is more indicative of the expected number for larger mesh fisheries. The undersized proportion for sole in the beam trawl fishery is low (0.4 per cent) which suggests effective selectivity whilst the proportion for plaice is higher (2.8 per cent) as a result of its larger minimum size. The high degree of selectivity of gill nets and long lines is demonstrated by the low and zero values for the undersized fraction. The range of selectivity measures that have been used are reflected in the tables at Annex 1 and 2.

Table 10: Proportion of undersized fish in the catch

Gear type	Species	Minimum landing size (cm)	Total catch (kg)	Undersized catch (kg)	Percentage of catch undersized
Beam	Plaice	27	10,820	303	2.8
Beam	Sole	24	17,301	67.92	0.4
Long line	Cod	35	15,623	0	0.0
Gill nets	Cod	35	36,725	91.5	0.2
Otter	Cod	35	187,446	8660.07	4.6
Pair	Cod	35	49,033	713.85	1.5

Discussion

This pilot aims to verify retained catch against catch documentation as well as monitoring for discards. Monitoring retained catch reduces the potential risk of under-reporting of catches or of discarding out of camera view or when cameras are switched off. Electronic monitoring is used effectively to monitor catches from static gear in Canadian fisheries such as the British Columbia hook and line fishery where precise counts of fish can be made and compared to counts recorded

in the fishing log. Quantifying catches where fish is taken aboard en masse is more challenging and is likely to require the ability to quantify units of volume such as full boxes.

Reduction of discards

Results to date show that discards for the key species have been assessed as being minimal (around 0.25 per cent). This low level of discards has been estimated by observing CCTV footage and REM data and we consider it inevitable that some very small amounts of discards will go unnoticed by crew.

The quantity of undersized fish that have been landed as a result of the discard prohibition (which would previously have been discarded) on participating vessels has generally been low, often less than one percent but with a considerable range across species and fisheries. For example, up to 43 per cent of the cod by-catch in the North Sea plaice fishery is undersized whereas undersized cod landings from larger mesh cod and haddock fisheries have been much lower at around 1 per cent. Larger volumes of undersized fish have been supplied to fish meal processors and smaller quantities either disposed of or supplied for bait.

The trial has demonstrated the ability to largely eliminate discards of certain stocks across a group of volunteer vessels without undue logistical problems in terms of handling and retaining undersized fish. The use of selective trawl designs which go beyond current technical rules by participating vessels is considered to be an important factor in minimising catches of small fish. Evidence on discarding suggests that although part of the overall discarded catch in North Sea fisheries is made up of undersized fish discards also result from insufficient quota, market prices and technical catch composition rules. It has not been possible, at this stage, to assess the proportion of catch that might have been discarded by trial vessels if they were not participating although it may be possible to examine market grade distributions between participating and non-participating vessels.

In the South West Dover sole fishery the trial has shown that catches of undersized sole are very low, with plaice showing a higher proportion as a result of its larger minimum size. Discards in this fishery are driven largely by quota restrictions which create incentives to high-grade the catch. The South West beam trawl fleet has demonstrated the successful use of increasingly selective trawls which reduce discards of juvenile fish and other benthic marine organisms. Although improved selectivity and discard reduction is considered very important by the South West industry they also believe that the level of discard mortality is low for some fish (such as sole, plaice, anglerfish) and that more research is required to assess whether a discard ban on some species could perversely increase fishing mortality because of the high survivability of these species.

Quantifying retained catch

Preliminary findings suggest that there are a number of areas which can be fine-tuned in order to improve the confidence of assessing retained catch and discards. REM with CCTV footage coupled with fully documented fishing presents a far higher resolution of events when compared to current surveillance methods but more precise methods of quantifying catches are required in order to provide adequate confidence in observer estimation.

We envisage that a programme of at-sea observer coverage can help to achieve this by providing quality assurance of catch estimates and promoting improved catch sorting behaviour and adjustments to CCTV equipment. Although observer trips are planned during the course of the trial, observers should be placed on board vessels soon after the installation of REM equipment. This allows for alterations to camera angles to be made as necessary whilst also providing an

opportunity to watch the fish sorting operation and make recommendations to revise handling procedures.

There can be significant variation between estimated catch on a haul-by-haul basis and logbook estimates with results showing that logbook estimates are often more accurate when compared to the landed weight. Masters of vessels working outside the Norwegian sector are required to complete catch estimates in the electronic logbook once every 24 hours and often derive this estimate from the quantities boxed in the fish room, rather than a total of the catches in each haul.

Such discrepancies require investigation to see how they can be improved in order to provide greater confidence in the accuracy of the documentation. Future work will investigate the potential for weighing catches where practicable and for quantifying volumetric units at the point of stowage.

Enforcing a discard ban

Proposals to phase in a discard ban across a range of key species represent a step change in fisheries policy and a new challenge for monitoring and surveillance. Currently there is already a ban on 'high-grading' where fish that are of legitimate size are discarded in order to preserve quota for higher value catches (typically the larger specimens). Enforcing the high-grading prohibition represents similar enforcement challenges to an outright discard ban as some form of first-hand witness evidence is generally required.

The lack of specimens within the smaller marketable grades within a landed or retained catch can be indicative of high-grading but is unlikely to be sufficient as evidence. This is also likely to be highly variable depending on the degree of selectivity and type of gear in use as well as fishing area. The use of on-board observers to monitor for discarding is likely to be effective but the cost and practicality is likely to be prohibitive. The use of REM/CCTV technology is likely to be more consistent as a means of policing a discard ban particularly as data can be reviewed randomly or through risk-based sampling.

Monitoring and surveillance

The system is not tamper-proof but the terms of the scheme place the burden on the vessel's master to check that the equipment is fully functional at all times and to report any malfunction immediately. Vessels can only go to sea if the equipment is fully able to capture the necessary data. Rolling out such technology on a statutory basis will require careful consideration on compliance and enforcement of the 'duty of care' to maintain equipment. It is evident that crew co-operation is an important element to successful monitoring using REM.

Vessel position and speed are captured on a 10 second interval and video footage of key catch handling areas is captured at a rate of 2 to 5 frames per second. Unlike vessel monitoring system (VMS) the data is not transmitted in real time but is stored on a hard drive which is removed in port for analysis. In this respect it does not allow for real time intervention or deterrence although the system can be modified to transmit electronic monitoring (EM) data such as position and gear hauling activity in real time. CCTV imagery can then be analysed subsequently for corroboration.

In terms of monitoring fishing activity we consider that the system offers reliable data on the correlation between fishing activity and vessel position. In the context of fisheries closed areas or gear specific prohibitions we consider that CCTV imagery can provide a higher evidential confidence than current VMS technology.

We consider that the integration of CCTV with REM data can provide greater assurance in catch location and prevent the misreporting of catch area. As such it could have the potential to negate the need for restrictive measures such as the single area licensing condition which currently applies to Western Channel beam trawlers and afford greater flexibility in fishing operations.

Potential implications for future management

Effort restrictions

As catch quota management effectively caps the amount of fish that can be caught there is a strong argument for removing effort restrictions applicable to single species management plans. Participating vessels are not able to deploy more effort than their quota allows for and once they have exhausted their quota they must cease fishing. By fixing mortality rather than effort, participating vessels have more flexibility to invest time in the avoidance of juvenile fish.

Catch composition rules

The prohibition of discarding North Sea cod has the potential to generate breaches of catch composition rules at any given point in a voyage. For example, vessels engaged in plaice or nephrops fisheries with less than 120 mm cod ends cannot discard cod to remain within the 20 per cent limit set by the North Sea technical measures. The system being trialled can potentially assist vessel masters to demonstrate avoidance of cod which in turn leads to the possibility of applying catch composition on landing rather than during the trip. We consider that introducing catch quotas on a mixed species basis could further lead to complications in meeting catch composition rules at all stages of a voyage and that the emphasis could potentially change to meeting composition rules on landing.

Quota imbalance

Current participants have demonstrated willingness to take part in the trials in order to contribute to the process of Common Fisheries Policy reform and, along with the wider industry, are increasingly looking for ways to improve the selectivity of gear and reduce discards. The nature of the mixed fisheries around the UK are complex and varied and discard rates are often directly linked to imbalances of quota amongst the mixed fishery species, particularly as a result of historically low catch shares (such as Area VIIe-k cod) or rapid changes in abundance and recruitment.

The provision of additional quota in exchange for an agreement not to discard is a key for participation. The amount of additional quota is set as a proportion of the expected discard rate for each species and therein lays a potential inhibitor applying catch quota management to a wider range of species. Each additional catch quota species potentially represents an increased risk of quota exhaustion leading to a complete stop if sufficient quota cannot be secured or where incidental catches cannot be avoided.

One vessel amongst the South West beam trawl participants has adopted the terms of the discard prohibition in respect of plaice and anglerfish. This has been the first initiative to examine the implications of a multi-species approach. Further evidence is needed to understand the impact of catch quotas for more than one stock in a fishery at a larger scale. Further research will be required to assess the impacts of fully documented catch quotas on a fishery by fishery basis.

Current catch quota regulation places a cap of 30 per cent on additional quota provided to offset a proportion of the amount that might otherwise be discarded. We consider the cap is set at a level that is too low to allow sufficient quota for high discard fisheries to be investigated under future

catch quota trials. While improved selectivity measures should be a key driver in reducing discard rates it may be appropriate to raise this cap for some fisheries such as North Sea plaice.

Industry engagement and views

Meetings were held with industry stakeholders to discuss progress with the trials and to get feedback from masters and owners. Participants have been positive about the progress of the trials so far and are keen to engage in future projects.

A key concern from the South West beam trawl industry is that not enough research is being undertaken to assess the level of discard mortality in key demersal species such as plaice, angler and sole. If discard mortality is low then compulsory landing of undersized fish could potentially lead to an increase in fishing mortality. Industry members suggest that survival rates for some demersal species are high as a result of improved sorting practices. Tagging projects and post-capture viability tests are currently being considered by the Centre for Environment, Fisheries and Aquaculture Sciences (Cefas).

Masters have expressed concerns about the level of record keeping that is required over and above the official logbook and it is intended, in any future schemes, to reduce this burden as far as possible without compromising the objective of verifying catch records.

There has also been concern about the method of allocating the additional quota. The Marine Management Organisation (MMO) has deemed a percentage of each landing to be drawn from each vessel's additional allocation. This methodology will remain in place for 2011 and consideration is being given to how best to manage any additional allocations in any scheme for 2012 while ensuring the principles of catch quota and reduction in fishing mortality are maintained.

Conclusion

Overall the trial to date suggests that the REM technology coupled with some form of verifiable catch documentation can provide a higher resolution of catch monitoring than current control and surveillance methods allow. It should therefore be capable of being used to contribute to achieving overall objectives to reduce discards in a phased approach and limit fishing mortality within sustainable limits. There would also appear to be scope for the use of catch and discard data for scientific purposes.

While the system is capable as a control tool it is considered that improvements can be made to improve the accuracy of catch estimation particularly where methods of counting volumetric units can be established. It also provides a means for fishers to be able to demonstrate good practice particularly in respect of demonstrating discard reduction or elimination, improved selectivity and avoidance of juvenile fish. Greater reliability on area of capture and incidental catches of non-target and vulnerable species can also be gained.

Key findings

1. Minimal quantities of discards (0.25 per cent of total catches) have been observed for discard-prohibited species during catch sorting operations, where some small fish go unnoticed by crew. This demonstrates the efficacy of the system as a means of reducing and monitoring

discards and ensuring that catch mortality is fixed.

2. Accuracy in estimating catches by both observers and fishing vessel masters on each fishing operation is subject to variation depending on the method of sorting and volume of catches. It is considered that alternative methods of quantifying catches should be explored as part of this pilot as well as ways of reducing the record keeping burden placed on vessel masters.
3. There can be difficulty in differentiating between certain species on CCTV footage, notably Dover sole and sand sole. In such circumstances a requirement not to discard either species could be considered in future trials in order to be able to police a discard prohibition effectively.
4. REM and CCTV equipment is considered to be operationally robust with few faults reported. Where faults have occurred rectification has been carried out without undue delay. Outsourcing technical support is considered to be necessary to ensure a reliable service infrastructure for future trials.
5. CCTV/REM analysis software is highly effective. However, quantifying catches can still be time consuming. It is considered that means of reducing analysis time should be explored as part of the ongoing trials.
6. Overall catches of undersized fish have been low and indicative of effective selectivity methods, although this data has not been analysed and compared to non-participating vessels.

Annex 1: Participating vessels – North Sea and proposed cod selectivity/avoidance measures

Vessel	Overall length	Engine power	Gear type	Additional quota (tonnes)	Species	Start date	Proposed selectivity and avoidance measures
1	14.95	298.4	Otter	18	Cod	15/3/11	Scalloping in May/June. Squid fishery in August. Area VII cuttlefish fishery in October. General avoidance of juvenile cod
2	9.8	186	Long line	6.8	Cod	15/3/11	Long lining for cod with large hooks. Sole fishery during the summer months.
3	21.5	485	Otter	62.5	Cod	04/3/11	130 mm cod ends. Diversification to flatfish and haddock fisheries or nephrops using large mesh square mesh panel or Swedish grid.
4	40.2	1880	Otter	5	Cod	12/4/11	Targeting deep-water saithe fishery with cod by-catch of less than 5 per cent.
5	18.91	186	Nets	11.4	Cod	02/3/11	170 mm gill nets to select for large cod with short soak time
6	17.27	142	Nets	15.7	Cod	24/3/11	170 mm gill nets to select for large cod with short soak time. Target Area VII pollack in summer months
7	18.25	309	Otter	15.8	Cod	18/3/11	Avoidance of juvenile cod. Target plaice over summer months.
8	18.26	309	Otter	18.8	Cod	30/3/11	Targeting saithe in the Norwegian sector and plaice in the summer.
9	18.27	350	Otter	21	Cod	11/3/11	130 mm cod ends for whitefish fishing. Diversification to oil standby work. Target nephrops for part of the year using 99 mm cod ends.
10	21.2	347	Otter	25.7	Cod	24/3/11	Use of large mesh square mesh panels. Avoidance of areas of abundance of juvenile cod, particularly inshore grounds.
11	21.67	448	Otter	27.6	Cod	22/3/11	Use of large mesh square mesh panels. Avoidance of juvenile cod abundance. Plaice and lemon sole fishery over summer months.

Vessel	Overall length	Engine power	Gear type	Additional quota (tonnes)	Species	Start date	Proposed selectivity and avoidance measures
12	23.13	354	Pair	32.4	Cod	11/3/11	Diversification to haddock, flatfish and Nephrops fisheries. Use of large mesh square mesh panel and Swedish Grid.

Annex 2: Participating vessels – Western Channel and proposed selectivity measures

Vessel	Overall length	Engine power	Gear type	Additional quota (tonnes)	Species	Start date	Proposed selectivity and avoidance measures
13	30.55	709	Beam Trawl	4	Sole	16/4/11	Increased mesh size in headline and belly. Targeting cuttlefish through the winter months. Diversification outside VIIe sole fishery for alternative stocks.
14	28	738	Beam Trawl	4.5	Sole	20/4/11	Increased mesh size in cod end and headline panel. Diversification from VIIe sole to other ICES areas and general avoidance of juvenile fish concentrations. Targeting cuttlefish through winter months.
15	23.97	220	Beam Trawl	3.3 2.4 .7	Sole Anglerfish Plaice	29/4/11	Use of square mesh cod ends, increased mesh size in headline panel and belly and improvements to ground gear to reduce overall discards of juvenile fish and benthos.

Annex 3: Terms and conditions

Catch-quota management scheme with remote electronic monitoring (REM) for North Sea cod

Overview

1. This is a voluntary scheme. It is based on catch-quota management, not on traditional landing quotas. The catch-quota management system (CQMS) will operate in the 2011 quota management year and be applicable to cod only.
2. The purpose of this project is to assess the capability of the CQMS to reduce discards, reduce stock mortality, provide better scientific data and encourage fishermen to fish more selectively.
3. The main features for vessels participating in the CQMS are that:
 - all cod caught shall count against quota; and
 - all cod caught shall be retained on board and landed; and
 - fishermen will have the responsibility to document that all fish caught are accounted for.
4. The main objectives of the scheme are to:
 - reduce discard levels
 - reduce fishing mortality rates for cod
 - 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
 - enhance our data collection and improve fisheries science and advice.

Eligibility

5. To allow for effective management, monitoring and communication, eligibility shall be limited to English vessels only. For the purposes of the CQMS an English vessel shall be defined as English administered at a Marine Management Organisation (MMO) coastal office.
6. In order to be eligible a vessel must be a member of a producer organisation (PO).
7. A vessel engaged in pair trawl activities shall only be eligible for the scheme if both vessels are signed up to the scheme.

Additional quota and days at sea

8. Each vessel will receive additional quota for cod based on evidence presented on its track record of annual landings (average yearly landings reference period 2007-2009 – fish landed under scientific dispensation schemes will not be included in this track record). The additional quota allocation will be based on the bid made in its application form. The maximum allocation is up to 30 per cent above the track record of cod a vessel has landed according to the reference period.

9. Once a vessel has reached its total quota allocation for cod it will be required to cease all fishing operations which can catch cod in the North Sea (ICES subareas IV, EU waters of IIa, the part of IIIa not covered by the Skagerrak and Kattegat). Vessels are therefore strongly encouraged to consider the use of highly selective gears and continue avoidance behaviours to ensure this scenario does not arise. While additional quota can be leased in during the year, this additional quota will not qualify for the pro rata increase in quota given at the start of the management year.
10. Vessels fishing in Norwegian waters with gear capable of catching cod must ensure that they have sufficient cod quota to account for any by-catch and so comply with Norwegian discarding rules. If such quota is exhausted then fishing operations must be stopped.
11. Participating vessels will be subject to the days at sea regime, and may be offered additional days at sea to encourage cod-avoidance behaviour. The amount of additional days made available will depend upon the overall constraints of the 2012 days at sea regime. Participating vessels cannot transfer out any additional days at sea.
12. Owners of participating vessels will be issued with a document ("a CQMS participation document") stating that they are part of the project, have had additional quota made available and have dispensation from specified offences that may occur in the routine operation of this scheme. The CQMS participation document must be carried on board the vessel at all times.

Discards and undersize cod

13. Vessels must not discard any cod.
14. Discarding of species other than cod will be allowed providing it adheres to the requirements of the High Grading Ban (for details of the high grading ban contact an MMO port office).
15. Undersized cod must not be sold or offered for human consumption but should be disposed of by sending for processing into fishmeal or offering as bait to static gear operators.
16. Undersized cod must be kept in separate containers and not be mixed with fish above the minimum landing size. Boxes of undersize cod should be stowed separately. Undersize cod that are landed must be clearly marked with an indelible food dye at the time of discharge in order that it cannot be sold for human consumption. The MMO must be notified of which processors or static gear operators have been nominated to handle undersized cod.

Remote electronic monitoring (REM) system

17. If the vessel is not suitable for the installation of the remote electronic monitoring equipment for any reason, the vessel may not participate in the scheme.
18. Positioning of cameras for the duration of the scheme will be decided in co-operation with the fishing vessel master so as to ensure that observers can monitor the process to obtain a good assessment of the catch. Cameras must not be moved or altered without approval from the MMO. Only personnel authorised by the MMO will be able to carry out repairs and maintenance.

19. Due to the need to cross-verify the effectiveness of electronic monitoring, observers will be required onboard participating vessels from time to time.
20. The sorting and handling of all catches must be carried out in full view of the cameras. Defra reserves the right to place additional cameras onboard participating vessels as required.
21. The systems must remain switched on at all times regardless of the sea area in which the vessel is operating.
22. In the event of equipment failure the master must notify the UK Fisheries Call Centre (UKFCC) as soon as they become aware of the failure. The trip may be completed before return to port but the vessel will not be allowed to return to sea until the equipment is fully functioning again. Early communication of any equipment problems will allow the MMO to take steps to ensure that the problem can be corrected as soon as possible on the vessel's return to port.
23. In relation to the equipment installed there shall be a duty of care placed on the master as laid out in the duty of care code. It is the responsibility of the master to ensure that crew are aware of and compliant with, the terms and conditions of the CQMS. Failure to do so will result in removal from the CQMS.
24. Skippers and crews must:
 - allow observers onboard and make suitable provision for their comfort
 - not tamper or interfere with the work of observers
 - not tamper or interfere with the on-board REM equipment
 - not deliberately block the view from REM equipment to the vessel's catch-handling areas
 - not deliberately attempt to handle or discard catch out of the view of REM equipment
 - not carry out trans-shipment operations (either receiving or donating catch) with other vessels.
25. The MMO will provide regular feedback to vessel masters on their catch handling procedures to ensure that catches can be monitored easily.
26. The REM system is the property of Defra. The master of the fishing vessel must make himself and the vessel available prior to the start of the scheme for a period of up to three days to allow installation of the monitoring systems and for one day after completion of the trial for the equipment to be removed.

Control and enforcement

27. It is important that vessels are inspected to ensure accuracy of data and that the rules of the project are being adhered to. Vessels will therefore be subject to ongoing monitoring and evaluation to confirm this. The master of the fishing vessel must facilitate vessels' inspections whenever requested by a Marine Officer.
28. The MMO will inspect vessels in port and at sea as part of their risk-based control regime.
29. Breaches of the scheme will be investigated by a disciplinary board consisting of the relevant Defra policy lead, the CQMS Trial Manager and the senior MMO official. The board will be responsible for establishing whether a vessel is deemed to have been non-compliant with the

requirements of the scheme. The disciplinary board's decision shall be final.

30. Any breach of the scheme that potentially indicates an offence in law will be handed to the relevant authorities for further investigation. Vessels prosecuted for a fishery offence that occurs within the duration of the scheme will be referred to the disciplinary board. The board will review the vessel's continued participation in the scheme in relation to the offence.

Conditions placed on the participating vessel

31. If a participating vessel is sold or exchanged, that vessel will be removed from the project. All remaining quota made available under the CQMS will be removed from the vessel's allocation.
32. In the instance of sudden unforeseen circumstances, such as sinking or disablement of a vessel, a replacement vessel may take part in the scheme providing the replacement is agreed by MMO prior to any commitment being made. REM equipment must be provided by the project participant.
33. Loss or damage caused by the negligent acts of the master or crew in relation to the REM system will not be the responsibility of Defra or the MMO.
34. Project participants must have sufficient insurance to cover the loss or damage of all parts of the REM system.
35. Defra or the MMO must be compensated for any repair or replacement to the REM system where damage or loss has occurred as above. The master of the fishing vessel shall not repair or replace any part of the REM system.
36. Project participants may be able to change vessel and remain on the project once in the project term. Any potential change should receive prior confirmation in writing from the MMO so that the owner can be sure that the replacement vessel will remain in the scheme before they make any commitment.
37. If a participating vessel is removed from the scheme, or leaves the scheme voluntarily, then the additional quota and days granted under the terms of the scheme will be deducted from their current and/or future allocations.

Data control and handling

38. MMO and Defra will appoint data controllers. Data controllers will determine dissemination of the recorded data.
39. Footage and data gathered may be used in an aggregated and anonymous form in publications and reports produced by, for and on behalf of MMO and Defra. All data will be treated as commercially sensitive. The data will be owned by Defra.
40. Enquiries made under Freedom of Information (FOI) legislation will be answered following normal FOI guidelines. However, personal data (which includes CCTV footage and data) will not be released.

41. System hard drives from vessels will be collected at regular intervals from vessels following liaison with the master of the fishing vessel. At this time a replacement hard drive will be fitted to allow the vessel to continue fishing operations.
42. Data from vessel hard drives will be transferred to a secure server for processing. The cleared hard drive will then be rotated back to the vessel.
43. The data/footage on the vessels' hard drives and servers will be erased after six months (from the date recorded), unless required for ongoing enforcement action. Some data may be temporarily retained for up to six months after the end of the project to provide a record of the scheme and allow scientific papers to be written.
44. Information obtained by the REM system and by observers will be retained and used for the purposes of the project only, except that such information may be released to other bodies if it is necessary for the investigation or prosecution of persons, or for any other purpose required by law.
45. Data may be retained for longer periods or for uses other than those listed above only with the express written consent of the vessel owners.

General conditions

46. All vessels operating in the scheme must complete an EU logbook regardless of whether they would complete such a logbook under normal fishing operations. All cod must be recorded in the logbook.
47. Vessels must also complete additional trip details as required by the MMO.
48. Participating vessels must immediately report to the UK Fisheries Call Centre (UKFCC) any catches that meet the catch rate trigger levels of the real time closure (RTC) scheme and/or the juvenile RTC scheme (contact MMO port office for details of RTC scheme). Project participants are not exempt from the real time closure schemes.
49. Participating vessels can buy-in and lease additional cod quota from other sources outside the CQMS. Bought in and leased cod quota will also be subject to the rules of the catch quota scheme. Participating vessels must not sell or lease out cod quota to vessels within or outside the catch-quota scheme.

Penalties

50. Vessels found to have breached the above conditions will be subject to a range of penalties depending on the seriousness of the offence. This will include removal from the scheme and deduction from current or future allocations of all their additional received quota and days.
51. Vessels removed will not be permitted to join any CQMS in the following year.

Change of scheme rules

52. Defra reserves the right to change any of the rules of the scheme at any time.

Remote electronic monitoring onboard English fishing vessels

Duty of Care Code 2011

1. MMO, or their representative, will fit cameras and sensors to the vessel. The master and crew will not interfere with the positioning of sensors or cameras.
2. The cameras and all equipment fitted remain the property of Defra.
3. The master must ensure that all discards can be monitored by the cameras.
4. The master will be expected to maintain clean lenses on the cameras at all times. We expect that cameras should be washed and dried on a regular basis and at least daily.
5. The master should ensure that the prescribed self test on the system is carried out at the start of each day to ensure that the full system is working correctly and that an action is electronically recorded by all cameras.
6. The master will report any damage, disruption or technical failure to the UK Fisheries Call Centre immediately:

Telephone: +44 (0)131 271 9700

Fax: +44 (0)131 244 6471

Email: UKFCC@scotland.gsi.gov.uk

7. The master will be responsible for maintenance and repair of the REM system. Only engineers authorised by MMO will be able to carry out repairs.
8. MMO will endeavour to resolve any technical problems promptly on the vessel's return to port. Early notification of technical failures will expedite that process.