Catch-Quota Pilot Study on the Dutch commercial fishery on cod (*Gadus morhua*) (first period: 2010-2012).

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Summary

The possibility to operate a catch-quota scheme on Dutch commercial fishing vessels was investigated in a pilot study on the commercial fishery on cod (*Gadus Morhua*). The project started at the end of 2010 and was fully operational, with five Dutch registered vessels, in 2011. To be able to implement a catch quota management system, monitoring and reporting of the total catches is an essential element. This might be done by using electronic monitoring (EM).

The participating vessels received up to 30% additional cod quota under the condition that all cod caught was recorded (including discards) and being deducted from this quota. To verify catches, each vessel was equipped with an electronic monitoring system, involving closed circuit television (cctv) and monitoring sensors. The basic principle of monitoring the catch-quota scheme was to check, using EM video recordings, whether the entire total catches of cod (i.e. landings and discards) was taken onboard and whether it was fully accounted for by the fishers in their logbooks. EM was used to randomly cross-check the logbooks catch entries with EM footage.

The two main objectives of this study are: 1) Evaluate the ability of EM to verify reported cod catches and 2) To explore a possible discard reduction of cod or other changes of fishing behavior under a catch quota regime.

Provided that all electronic monitoring equipment is up and running and footage is recorded from the right positions onboard the vessels, then, according to the results of this pilot study, EM is able to verify reported cod catches. However, the results do not demonstrate a reduction of discards nor a behavioral change among participants as a response to the catch-quota regime. Note that this result is based on a very low sample size only.

Results of this study demonstrate the potential of EM as a valuable monitoring and possible enforcement tool that might be used to successfully implement innovative management schemes like a catch-quota regime.

Introduction

The Common Fisheries Policy (CFP) determines that fisheries in the EU are managed on the basis of Total Allowable Catches (TAC's), which places a cap on the amount of fish that can be landed over the year. These landing quotas encourage the fishers to increase the value of the landed catch but do not provide incentives to optimize the value of their total catch, i.e. including discards, since the fishermen are not held fully accountable for the total removal of fish from the stock.

To increase accountability and to encourage selective fishing methods, a catch quota management system has been under consideration by the European Commission and several Members States in cooperation with the industry. A catch quota management system manages a fishery on the basis of the amount of fish that has been caught instead of the amount of fish that has been landed. The amount of quota each fisherman holds is deducted by the amount of fish caught including small-sized fish that have no commercial value, which provides the fisherman incentives to minimize the amount of discards.

To be able to implement a catch quota management system, monitoring and reporting of the total catches is an essential element. This might be done by using Electronic Monitoring (EM) on board fishing vessels (Course et. al., 2011; Dalskov et. al. 2011), which involves monitoring of the catch with Closed Circuit TV (CCTV).

To investigate possibilities of the Dutch fishery to participate in a European catch quota system, the Dutch government, has started a pilot project in cooperation with the industry: *Catch-Quota Pilot Study on the Dutch commercial fishery on cod (Gadus morhua)*. The two main objectives of this project are:

1) To evaluate the ability of EM on board vessels to verify reported cod (*Gadus morhua*) catches.
2) To explore a possible discard reduction of cod (*Gadus morhua*) or other changes of fishing behavior under a catch quota regime.

Therefore, the purpose of the comparison and analysis of reported catches and CCTV footage is twofold: It evaluates the usability of the EM equipment as a catch monitoring tool, and it also assesses the potential of a catch quota management system that is based on real catches rather than reported landings, to reduce discards and encourage fishermen to fish more selectively in the cod fishery.

Five trawler skippers who normally target cod participated in the project, which started in January 2011. Their vessels have been equipped with an EM system. This report describes the results based on data collected during the first period of the project, from January 2011 until August 2012. A second phase of the project has started in August 2012, when the pilot study was scaled up with an additional seven vessels.

Materials and Methods

General

The methodology applied in the Dutch catch-quota pilot study is based on the methodology applied in the Danish project Fully Documented Fisheries (Dalskov and Kindt-Larsson, 2009). The participating vessels have been equipped with EM systems provided by the Canadian company Archipelago Marine Research Ltd. The EM systems record the activities on deck from four angles or locations on the vessel and record the position, date, time of shooting and hauling of the gear. Typically one camera gives an overview of the working area on deck, one camera covers the hold where the catch in the codend is hoisted above, a third camera is located above the conveyor belt where the catch is sorted and one camera focusses on the part of the conveyor belt where the discards falls into a gutter (see figure 3). The recordings of the EM systems are stored on hard disc drives. At the start of the project these drives were installed by the Dutch company Piet Brouwer Elektrotechniek. Retrieval of full drives and installation of new ones was carried out by Piet Brouwer Elektrotechniek during the first months. After a system upgrade, in May 2012, the process of retrieval and installation became less complicated, this task was taken over by the crews in collaboration with IMARES. Skippers sent full disks to IMARES for analysis. After analysis, the disks were erased and formatted and sent back to the skippers. Each vessel had one spare disk on board to be able to install a new disk immediately after a disk was filled up with data. This way each vessel maintained their own hard-drive rotating system.

Together with the full hard drives, skippers provided electronic logbook (Excel) sheets with cod catch records by market size class and discards. At IMARES video footage from the EM systems was compared to the logbook recordings of fishermen by means of random checks of the recorded fishing days.

Terms and conditions for participants

The participation of vessels in the pilot project is subject to three obligations, namely:

1) Participants are obliged to retain on board and land all marketable sized cod. Only non-marketable undersized cod is allowed to be discarded.
2) Report all their cod catches. More specifically, participants have to record the weight of the total catch of cod and the weight of the catch specified for the length classes (in cm) >88; 72-88; 55-72; 46-55; 35-46; and <35.
3) All cod catches are subtracted from their cod catch quota. To compensate for the amount of cod discards that is being subtracted from their quota, each participant obtains 30% extra cod quota.

See Annex 1 for detailed terms and instructions for participating skippers.

Participating vessels

In total five vessels have been selected for the project, power ranging from 200 to 1100 kW, here called vessel 1 to 5. One vessel had to resign from the project due to the sale of the vessel in March 2011. At that time the vessel had not yet collected usable data and is therefore left out of the analysis in this study. It was replaced by vessel 5. Information on landings and quota about the participating vessels is provided in table 1. All vessels target cod during a certain period of the year and enough cod quota to have an incentive to participate in this project.

Table 1. Landings of participating vessels in Dutch Catch Quota Management Project in the cod fishery 2011-2012

Vessel	*Vessel Type*	*Cod landings in 2010 (in tonnes)*	*Additional cod quota 2011 (in tonnes)*
Vessel 5	Trawler	27,0	21,7
Vessel 1	Trawler	59,1	18,7
Vessel 2	Trawler	63,6	16,4
Vessel 3	Trawler	2	10,3
Vessel 4	Trawler	128,7	16,5

All vessels fished with varying mesh sizes, depending on area and season. Figure 1 provides an overview of the total of fishing effort in days at sea (D.A.S.) by quarter and gear category for the five participating vessels together. The following gear categories are defined: otter trawler or fly-shooter (Danish seine) with mesh size in the cod-end larger than 120mm; otter trawler or fly-shooter (Danish seine) with a mesh size in the cod-end between 99 and 120mm; TR2 = otter trawler or fly-shooter (Danish seine) with a mesh-size in the cod-end between 79 and 100mm.

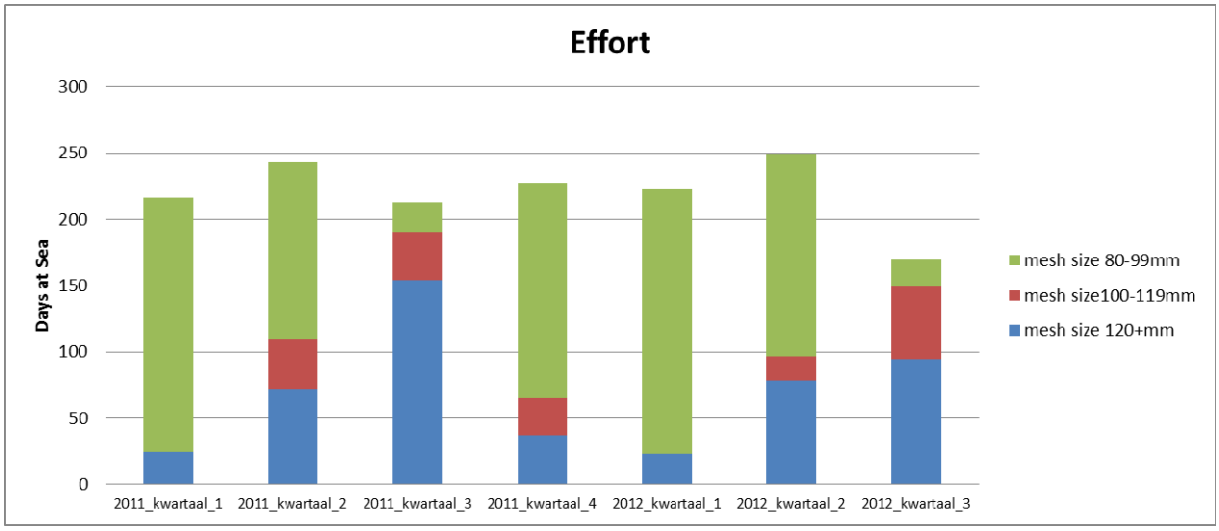

Figure 1. Fishing effort in days at sea (D.A.S.), by quarter and mesh size category between Jan 2011 and Aug 2012, a total over the five vessels participating in the Dutch catch-quota pilot study.

In 2012 the pilot has been extended with 7 more vessels, to (1) collect more test results, (2) to gain more experience with EM to design tailor made approaches per fishery segment , (3) to further decrease discards of cod and (4) to anticipate to the expected obligations in the new Common Fisheries Policy (CFP). See Annex 2 for a list of all participating vessels in September 2012.
Between December 2010 and March 2011 the EM systems have been installed on all participating vessels. The EM systems consist of four waterproof armored dome CCTV cameras, GPS, hydraulic pressure transducer and a photoelectric drum rotation (winch) sensor as shown in figure 2. In the wheelhouse a control box monitors the sensor status and the image recordings. Depending on the settings, data collection automatically starts either after drum rotation, building up of hydraulic pressure or after the vessel leaves an imaginary “box” around the port. The systems used are similar to the systems used in the project conducted in Denmark (Dalskov and Kindt-Larsen, 2009) and the project conducted in the United Kingdom (Course et al., 2011).

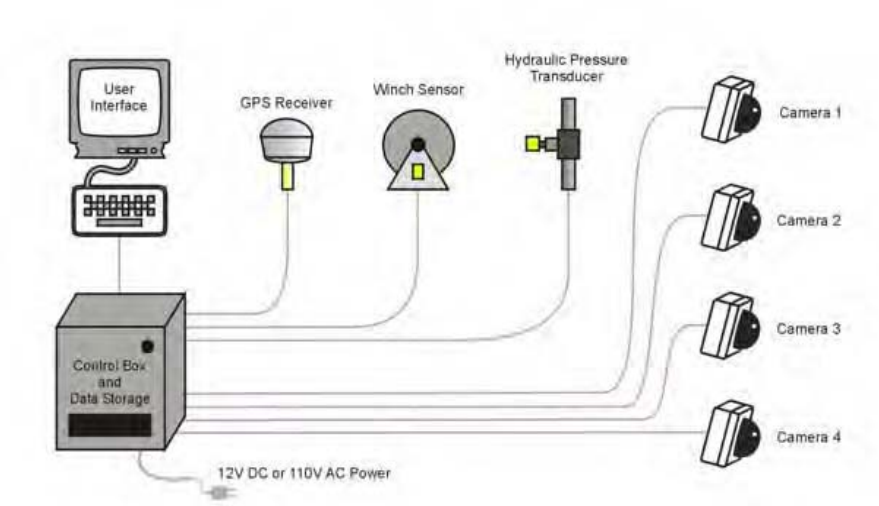

Figure 2. Schematic diagram of the components of a EM System.

Figure 3. An example of a camera set up on board one of the vessels. Camera 4 is here positioned opposite to camera 3, which is not the usual position on most vessels. Typically one camera provides an overview of the complete working deck.

Data analysis

The EM data were analyzed with EM Interpret Pro™ software. From the collected EM data a list of active fishing days was created. For each individual fishing day, it was checked if the video image was recorded correctly and if it was possible to analyze recorded footage. Dirty camera lenses made it sometimes impossible to analyze the recorded footage. From this list a number of days was randomly selected to cross check with the logbook recordings.

Footage from each selected day was analyzed. For every haul, lengths of all individuals identified as cod, was estimated in cm size classes of >88; 72-88; 55-72; 46-55; 35-46; and <35 in both the retained catch and the discarded fraction. These size classes correspond with auction market categories in the Dutch harbors.

Not all participating skippers entered numbers of cod catches by market category into their logbooks, but instead weights by category or weights of total cod catches. Therefore, numbers of cod identified by size category were transformed to total weights by day using a length weight converting factor derived from survey and market sampling at IMARES.

Logbook recordings and results from the EM analysis were compared. A regression analysis was used to define the relationship between logbooks and EM imagery. A T-test analysis for matched pairs (paired T-test) indicates if there is a considerable difference in the amount of discards between logbook recordings from skippers and EM imagery.

Analysis of cod catches, catch per unit of effort and discard percentages, are based on logbook data, since EM data was only used to randomly cross check skippers recordings. A possible discard reduction of cod was evaluated by comparison with discard estimates from other monitoring programs (Data Collection Framework and the cod monitoring program of IMARES) covering the same sampling period and gear classes (>120mm, 100-119mm, 80-99mm: see figure 1). A possible change of fishing behavior, as an effect of the catch quota regime, was investigated with commercial landings data of cod from the VISSTAT database by comparing landings of vessels without an EM system on board with landings from the logbooks over the period 2011 up to August 2012.

All statistical analysis were done using SAS 9.2 (SAS Inc., Cary, North Carolina).

Results

Operational performance

A schematic overview of the data collected during the first phase (2011 and 2012) of the Dutch catch-quota pilot study is given in figure 4.

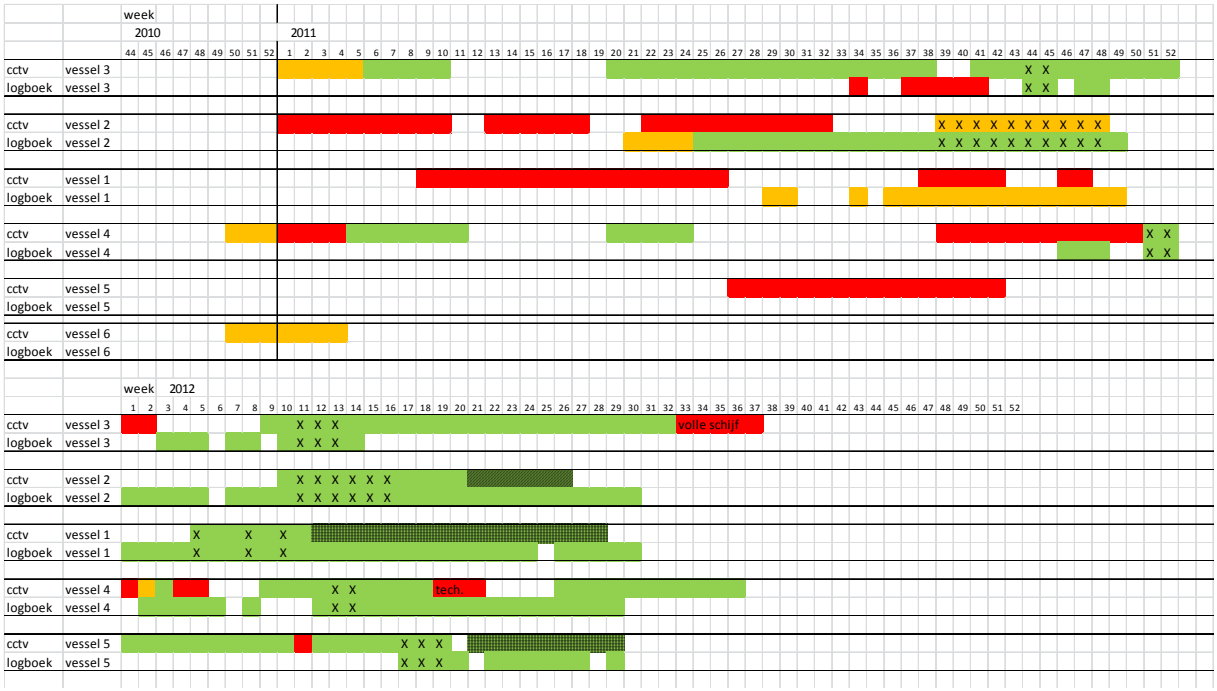

Figure 4. Schematic overview of EM system conditions and cooperation regarding logbook sheets by vessel: cctv (red)= poor quality of the footage, cannot be used to determine catch; cctv(orange= poor quality of the footage, can be used to make a rough estimation of the catch; cctv (green)=good quality, can be used to estimate catch; cctv(blank)=no hard drive was installed to collect data; cctv (shaded cells)= indicate a hard ware problem e.g. damaged or incorrectly formatted hard drive. Logbook (red)= log sheets are not filled out correctly or do not contain all necessary information; logbook (orange)= logbooks are not filled out according the agreed format, but still give catch information; logbook (green)= log sheets are filled out correctly and contain all necessary information; logbook (blank cells)= log sheets received. X= logbooks verified with EM data. Vessel 6 had to resign from the project due to the sale of the vessel in March 2011.

A summary of the data collected and the calculated 'performance levels', expressed as a percentage from the total in weeks, is given in table 2. The percentage of EM data gaps and insufficient, not analyzable, EM data decreased considerably during the course of the project. Insufficient EM data were almost always the result of ineffective camera positions, e.g. wrong camera angle, camera too far away from the sorting belt, positioned behind the backs of fishermen when they sort the catch, and lack of maintenance, specifically not cleaning the camera lenses. Technical failure of the EM system increased, possibly a logical consequence of the endurance of the material over time. Logbook data gaps considerably decreased and insufficient logbook data even reduced to zero in 2012.

Over time all stakeholders got more familiar with the project and gained experience in operating the EM systems. This, eventually, resulted in higher performance levels, as expressed in the increase in availability of overlapping, and therefore, comparable logbook- and EM data, from 6% to 25%, from

January 2011 to August 2012. For 6% and 11% of the total number of weeks in 2011 and 2012, respectively, logbooks were actually verified with EM footage.

Table 2. Overview of EM data and logbook data from start of the project in week 1 2011 to the end of phase 1 in week 30 2012.

Parameter	2011		2012	
	No. of weeks	Percentage(%)	No. of weeks	Percentage(%)
Total	226	100	150	100
EM data gaps	77	34	33	22
Insufficient EM data	84	37	9	6
Technical failure EM	0	0	32	21
Logbook data gaps	165	73	46	31
Insufficient logbook data	6	3	0	0
Comparable EM-logbook matches	14	6	38	25
Actual verification of logbooks	14*	6	17*	11

*) No. of weeks verified: at least one day from a selected week the logbook was verified with EM footage.

Catch data analysis

Catch per Unit of Effort

Based on logbook data, catch per unit of effort (CpUE) was calculated, where catch is weight (kg) of cod caught, landings and discards together, and effort is engine power (kW) times fishing days. Catch per unit of effort by gear category by quarter is given in figure 5 and table 3.

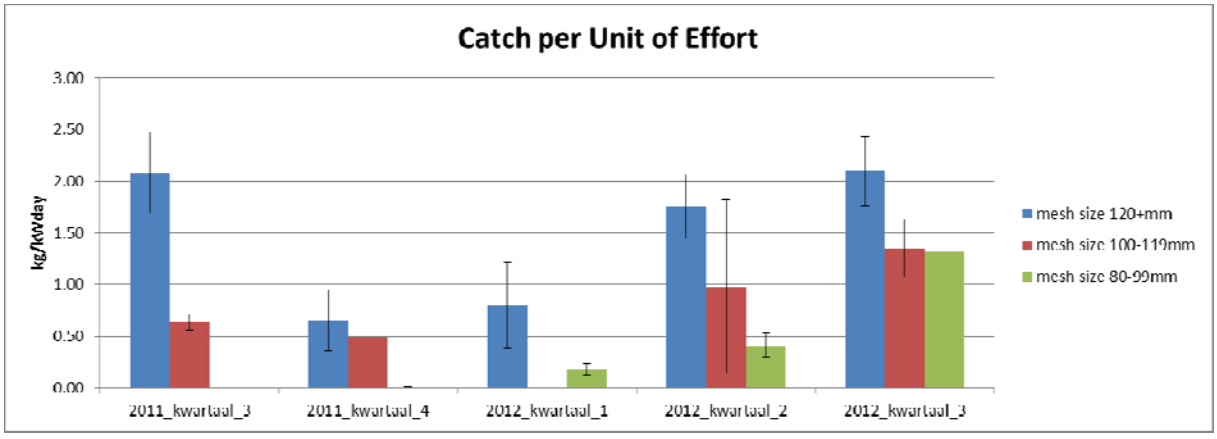

Figure 5. Mean Catch per Unit of Effort (CpUE) in weights per kW days (kg/kWdays) per quarter +/- the standard error (error bars).

Catch per unit of effort peaked for all gear categories during the third quarter of the year, both in 2011 and 2012. CpUE of 100-119mm and 80-99mm is lower than for 120+mm in all cases, demonstrating that otter trawling or seining with a mesh size larger than 120mm, is the most efficient gear to catch cod. However, this gear type is not the predominantly used throughout the year, only in the third quarter it is the main gear type (figure 1). This indicates a seasonal trend in the commercial fishery on cod.

Table 3. Mean Catch per Unit of Effort (CpUE) in weights per kW days (kg/kWdays) and the number of observations (n days) by quarter.

	2011_kwartaal_3	2011_kwartaal_4	2012_kwartaal_1	2012_kwartaal_2	2012_kwartaal_3
120+mm	2.09 (n=14)	0.66 (n=17)	0.80 (n=16)	1.76 (n=28)	2.10 (n=10)
100-119mm	0.64 (n=4)	0.49 (n=1)		0.98 (n=3)	1.35 (n=4)
80-99mm		0.01 (n=2)	0.18 (n=26)	0.41 (n=19)	1.32 (n=1)

Discards Percentage

Discard percentage is calculated as the weight fraction of the cod catch that went overboard against the cod that was retained on board by day, based on logbook data.

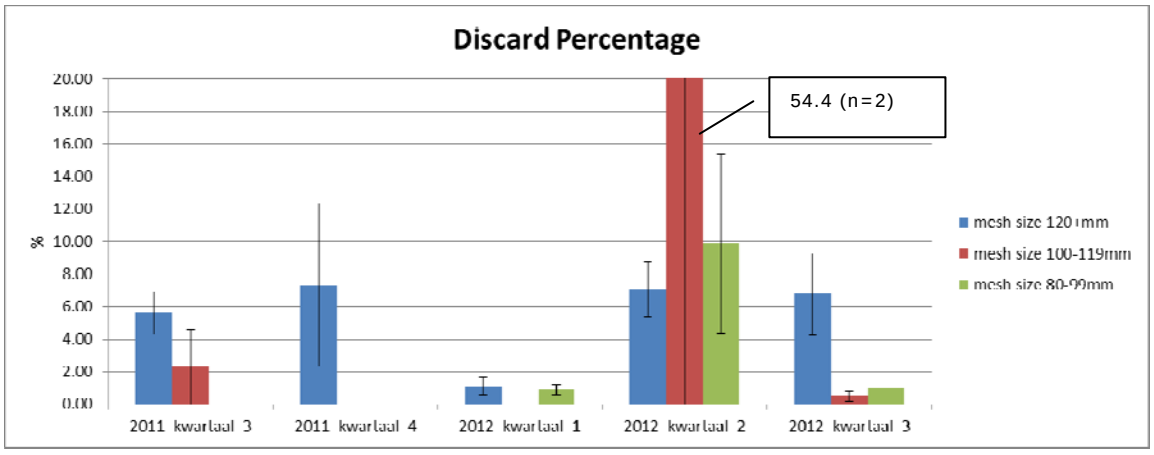

Figure 6. Mean discard percentage by quarter (+/- standard error) based on weights of the discarded fraction of cod against the retained fraction of cod.

Overall the discarded fraction of cod is low, less than 10% of the landed catch, except for 100-119mm in the second quarter of 2012. The extraordinary high discard rate of 54% is the result of more than usual discarding of cod during one trip out of two trips in the second quarter of 2012 (n=2, see table 4).

Table 4. Mean discard percentage based on weights of the discarded fraction of cod against the retained fraction of cod and the number of observations (n days) by quarter.

	2011_kwartaal_3	2011_kwartaal_4	2012_kwartaal_1	2012_kwartaal_2	2012_kwartaal_3
120+mm	5.6 (n=13)	7.3 (n=16)	1.1 (n=16)	7.0 (n=27)	6.8 (n=10)
100-119mm	2.3 (n=4)	0.0 (n=1)		54.4 (n=2)	0.5 (n=4)
80-99mm		0.0 (n=2)	0.9 (n=17)	9.9 (n=18)	1.0 (n=1)

Comparison of logbooks against EM footage

A consequences of the seasonality in the cod fishery is that cod catches are temporarily high, during the cod season, and much lower for the rest of the year. When we compare records of logbooks with EM imagery throughout the year this results in a tight cluster of observations of low cod catches and just a few records of high cod catches. To spread the records of comparisons more uniformly, data were log transformed. Log transformed records of logbook and estimates from EM footage were plotted against each other in figure 7.

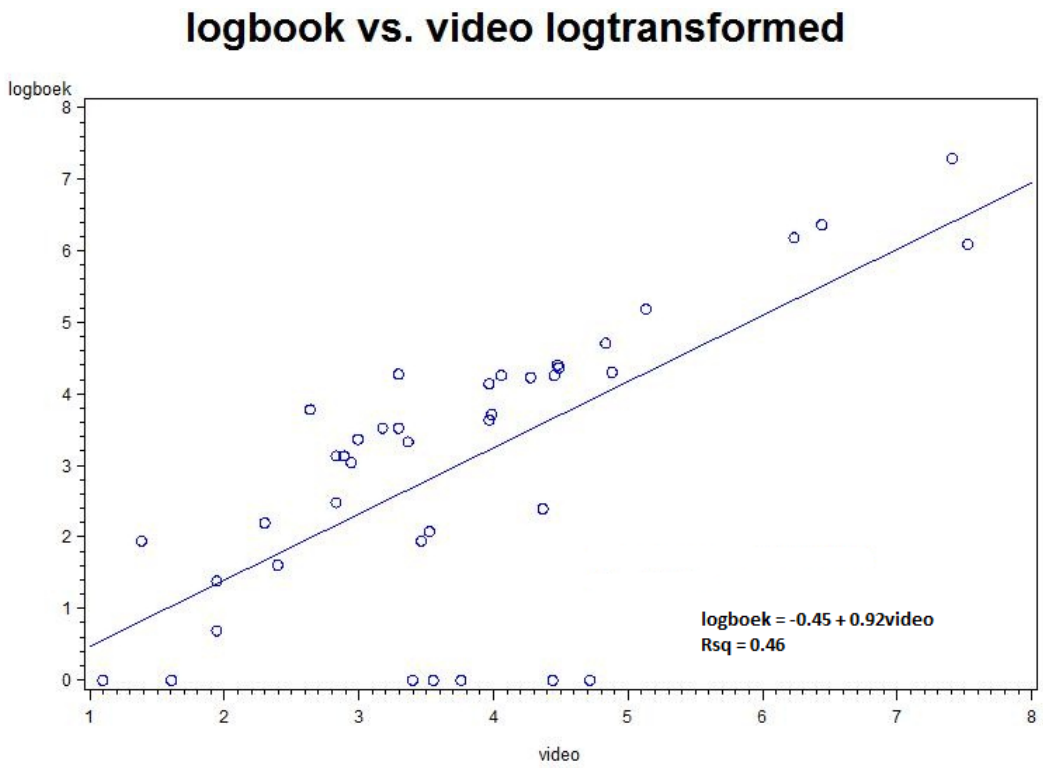

Figure 7. Log transformed logbook records of cod catches on y-axis against log transformed estimates from cod catches from EM footage on x-axis. Equation from the regression line and regression coefficient (R-square). Note that the slope of the regression line is strongly influenced by 5 (or7) 'inaccurate zero estimates' in the logbook (see main text below).

Ideally, the logbook records and records estimated form the EM footage would be the same and, therefore, be perfectly linearly correlated in a 1-to-1 relationship. A regression analysis indicates that the linear relation between logbook and footage is significant ($p<0.05$), see figure 7 and table 5.

*Table 5. Results from linear regression analysis (preformed on log transformed data). Slope of the regression line with standard error, T- and p-values of the regression (***= highly significant) and number of observations.*

	Regression line			
	Slope (+/- stand. error)	T-value	p-value	N
Logbook vs. video	0.92 (0.16)	5.85	<0.001***	40

However, a paired t-test analysis, where pairs of logbook and footage records are compared by each observed day, shows that observations from skipper (logbook) and observations from EM footage are significantly different (P< 0.05), see table 6.

*Table 6.Results from paired t-test. T- and p-values (**= significant) and number of observations.*

	Paired t-test		
	T-value	p-value	N
Logbook vs. video	-3.25	0.0024**	40

At the start of the project two participating skippers filled out the logbooks imprecisely and consequently marked zero cod catches when they were targeting other species, while on EM footage (by-)catches of cod were identified. This resulted in a considerable mismatch between logbook records and EM footage. After the fishers received feedback and it became clear to them that *all* cod catches had to be recorded, matches between logbooks en EM footage improved considerably.

Therefore, the misreported zeros were omitted in the following regression analysis. Log transformed records of logbook and EM footage, without these seven 'inaccurate zero-estimates', were plotted against each other in figure 8.

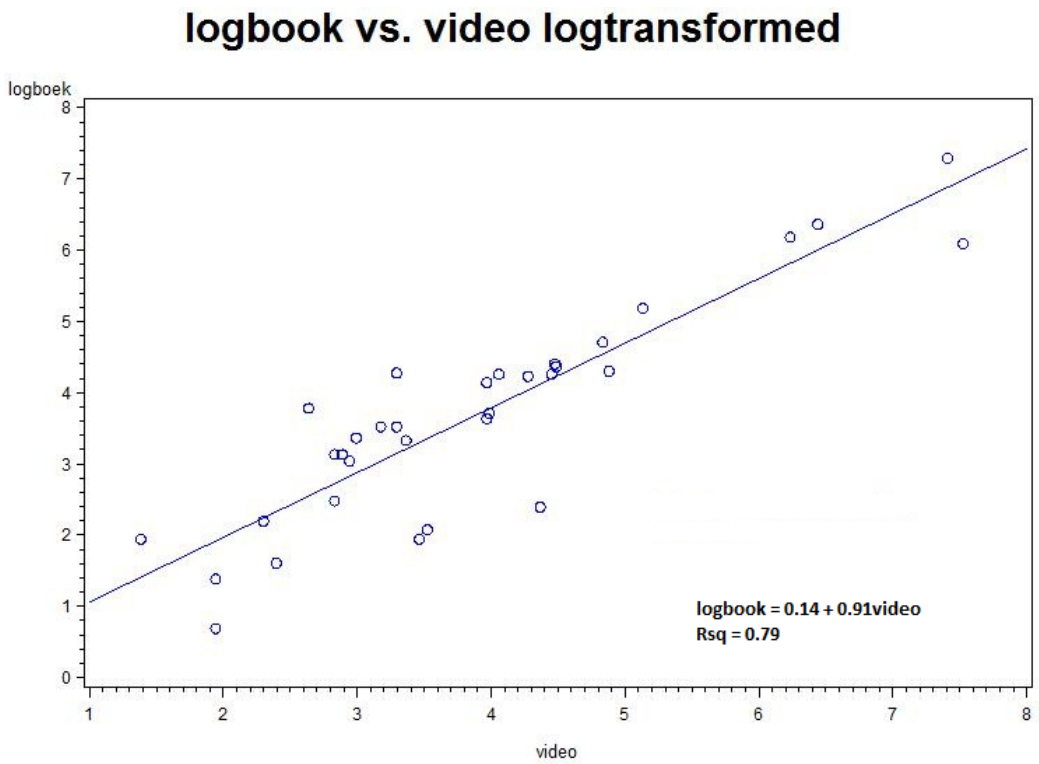

Figure 8. Log transformed logbook records of cod catches on y-axis against log transformed estimates from cod catches from EM footage on x-axis, excluding 'inaccurate zero-estimates' (see main text). Equation from the regression line and regression coefficient (R-square).

A new regression analysis based on input data without 'inaccurate zero-estimates' indicates that a linear relation between logbook and footage is significant ($p<0.05$), see figure 8 and table 7. The correlation coefficient (R-squared), the strength of the linear relationship between the variables, increased from 0.46 to 0.79 (figure 7 and 8).

*Table 7. Results from linear regression analysis (preformed on log transformed data). Slope of the regression line with standard error, T- and p-values of the regression (***= highly significant) and number of observations.*

	Regression line			
	Slope (+/- stand. error)	T-value	P-value	N
Logbook vs. video	0.91 (0.08)	10.97	<0.001***	33

The results of a paired t-test show that observation from skipper and estimated from EM footage, without 'inaccurate zero-estimates', are not significantly different ($P< 0.05$), see table 8.

Table 8. Results from paired t-test. T- and p-values (ns= not significant) and number of observations.

	Paired t-test		
	T-value	p-value	N
Logbook vs. video	-1.69	0.10 (ns)	33

Fisher behaviour and change of fishing pattern

Comparison with other monitoring programs

A possible discard reduction of cod, as an effect of operating under a catch quota regime, was evaluated and compared with discard estimates from two other monitoring programs run by IMARES:
1) A combined observer and reference fleet program to monitor discards under the Data Collection Framework (DCF) of the EU. This program monitors discards of all species and all gear types, i.e., it is not designed to specifically sample cod discards.
2) A self-sampling program within the framework of a cod recovery plan by the Dutch Ministry of Economic Affairs, Agriculture & Innovation. This program does monitor cod specifically and is thus better suited for comparisons with results of our catch quota pilot study. Vessels monitored in other programs were not equipped with EM systems. The average portion of cod discards by vessels participating in the catch-quota pilot study were not systematically lower than vessels participating in other monitoring programs (table 9 and figure 9). In fact, discard percentages of the 120+mm gear category were consistently higher for vessels operating under the catch-quota scheme (maybe, an effect of the presence of cameras). Remarkable is the similar irregularly high discard estimate for 100-119mm in 2012 for both CCTV and DCF, also because this is caused by one trip in case of CCTV (see section of discard percentage 3.2.2.).

Table 9. Average discard percentages (and number of observations) by gear category (120+mm, 100-119mm and 80-99mm) for three different monitoring programs: catch-quota pilot study with EM systems (CCTV), Data Collection Framework by EU (DCF) and self-sampling program of the Dutch Ministry (self-sampling).

	CCTV		DCF		Self-sampling	
	2011	2012	2011	2012	2011	2012
120+mm	6.6 (n=29)	5.2 (n=53)	0.2 (n=3)		0.4 (n=22)	0.12 (n=41)
100-119mm	1.8 (n=5)	18.5 (n=6)	3.3 (n=11)	18.0 (n=11)	0.0 (n=3)	4.0 (n=17)
80-99mm	0.0 (n=2)	5.4 (n=36)	3.1 (n=22)	1.4 (n=4)	0.3 (n=18)	0.9 (n=136)

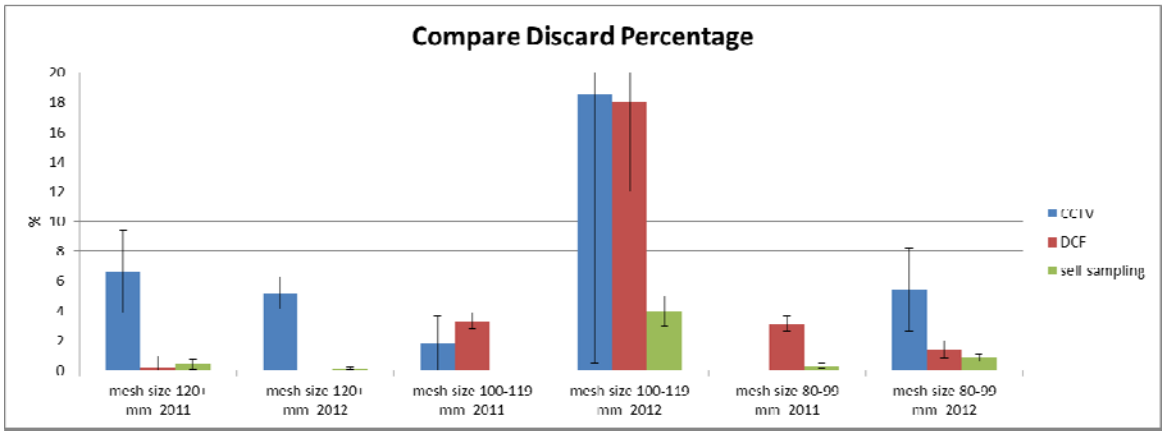

Figure 9. Average discard percentages and standard errors (error bars) by gear category (120+mm, 100-119mm and 80-99mm) for three different monitoring programs in 2011 and 2012: catch-quota pilot study with EM systems (CCTV), Data Collection Framework by EU (DCF) and self-sampling program of the Dutch Ministry (self-sampling).

Market category distribution of landings

The vessels participating in this pilot project have according to the terms and conditions for participating (see section 2.2) to retain and land all cod above the minimum landings size. According to the Danish study of Kindt-Larsen et al. (2012) this condition has an effect on the fisher behaviour and fishing pattern of fishers operating under a catch-quota scheme. Like for most species, the price per kg cod increases with fish size, this gives the opportunity for a vessel to optimize the value of a quota by only retaining large fish and discarding small marketable fish. This type of illegal discarding is known as high-grading (Dalskov et al., 2011). The conditions of the catch-quota scheme presents the fishers with an incentive to optimize their fishing operations. Any catches of undersized or less valuable fish will reduce their incomes; all catches, including discards, are deducted from their quota, optimizing their quota by discarding small marketable fish is, therefore, not an option. The Danish research results point out that vessels without a catch-quota scheme optimize their catch through high grading and, consequently, land less fish of the smallest, and less valuable, size classes and, in proportion, more fish of the largest, more valuable, size classes.

A similar study on size grade distribution of landed cod in 2011 and 2012 up to August, was done for the Dutch project. Proportions of cod landings by market category of seiners and otter trawlers, with a mesh size > 99mm and targeting cod during a certain period of the year without EM on board (n=13 vessels in

2011 and n=9 vessels in 2012) were compared with proportions of cod landings by market class for the vessels with EM on board (n= 3 vessels for both 2011 and 2012[1]). Results are given in figure 10.

Results of the Dutch pilot study of 2011 concur with the results of the Danish program. The proportional share of market categories (35-46cm, 46-55cm, 55-72cm, 72-88cm and 88+cm) were not considerably different between vessels with an EM system on board. Possibly, a potential "EM effect" could be recognized for the smallest market category in quarter 4 and 1 for 2011 and 2012, respectively. A relatively small share of market category 35-46cm possibly indicates some high-grading among vessels without EM on board, but differences with EM vessels are marginal.

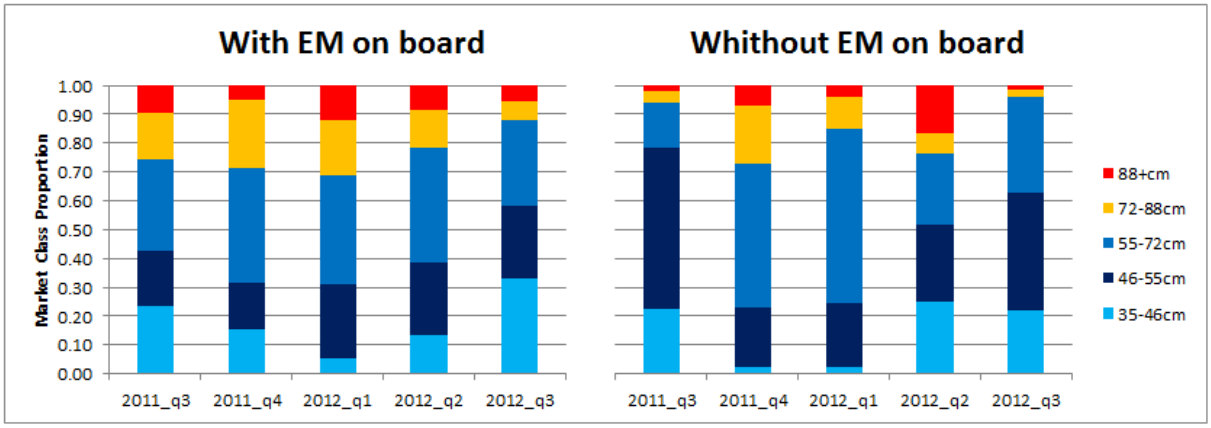

Figure 10. Proportion of cod landings by market category for vessels with and without an EM system on board for 2011 and 2012 by quarter.(n= 3 vessels with EM in 2011 and 2012; n= 13 vessels without EM in 2011 and n=9 vessels without EM in 2012).

[1] 2 of the 5 participating vessels did not specify their cod catches by market category.

Discussion and Conclusions

EM is an accurate method to verify reported cod catches

The results of this pilot study show that EM is an accurate method to verify reported total catches of cod (including discards) on board (see section 3.3), provided that the complete EM system is operational and maintained in good condition. Malfunctioning components in the EM system affected the efficiency of the project as a whole. For example, one dirty camera lens could lead to the problem that catch recordings of a complete trip could not be appropriately verified with EM footage. Thanks to improving communication between scientists and fishers and additional or repeated operational and technical instructions over time, all stakeholders got more familiar with the project and gained experience in operating the EM systems (figure 4, table 2). During the project a lot of improvements took place, which gradually resulted in improved data quality and made, eventually, sufficient data analysis possible.

We conclude that the use of EM video recordings worked well to verify whether a total catch of cod (i.e. landings and discards) was fully accounted for by the fishers in their logbooks. Overall, logbook catch records corresponded with catch estimates based on EM footage; there was no significant difference between these two sources (table 8). Misreporting was discovered in two cases (see misreporting of zero-catches in section 3.3). A significant difference between catches based on logbook records and EM footage was detected only, when misreports were included during analysis.

Practical lessons learnt

The difficulties and challenges encountered during the course of the project allow us to draw general conclusions. In the following, we provide a list of the main lessons learnt:

1) *Positioning of cameras and dirty lenses*. EM systems need to be installed correctly (this includes sensors, hard drives, software and CCTV system). It is important to realize that after installation, the equipment requires maintenance.
   After installation camera positions have to be adjusted on all vessels.
   Two important reasons that caused data loss at the start of the project:
   (a) The position and the angle of the camera need to be adjusted to prevent misreporting, e.g. camera too far off the sorting belt, or crew members in front of the camera when sorting the catch.
   (b) the lenses of the CCTV cameras have to be kept clean.
   Camera positions were checked when IMARES received the first hard drive of a vessels. An early check of camera positions reduces data loss.
2) *Logbooks.* Correctly filled out logbooks are a crucial component in the catch-quota system. EM footage/data is only used to randomly check a small part of the logbooks. In a fully operational catch-quota regime, data retrieved from logbooks will form the basis for quota management. EM is just a tool to verify if catches are fully accounted for by the fishers.
   In our pilot study, some participating fishers did not send in logbooks or they sent them in an inadequate format that could not be analysed. After the participants were given feedback, the number of logbooks started to arrive more frequently and in a format that was appropriate for further analysis.
3) *Hard drives*. Organisation of hard drive logistics turned out to be an important factor during the project. At the start of the project, hard drives were not send to IMARES automatically, once they were full and stopped collecting information. This, obviously, resulted in EM data gaps and the lack of opportunity to verify logbook data. The absence of well-defined responsibilities

amongst all stakeholders was problematic, e.g.: When are hard drives sent back for analysis? Who sends new or re-formatted drives to vessels? Who is responsible for (re-) formatting used drives? Some vessels continued sailing for months with full hard drives. More frequent communication between stakeholders and IMARES (research), taking over some tasks from Piet Brouwer Elektrotechniek (technical assistance in the field), improved the logistics around the hard drives considerably.

4) *Converting video estimates to catch weights*. Verifying catch records of fishers with EM data is basically done by counting the number of fish on a video screen and compare these number with what is recorded in the logbooks.Not all participating skippers filled out logbooks in numbers of cod catches by market category, but in weights by category or weights of total cod catches. Therefore, numbers of cod identified by size category had to be transformed to weights by applying a length weight converting factor. Using a conversion factor influences the accuracy of the estimates based on EM footage, and this, finally, has an effect on the comparison of records between logbooks and EM. Such conversions can actually create artificial differences between catch reports based on logbooks and EM footage.
5) *The implementation of a steering group committee*. A committee with representatives of all stakeholders, and regular meetings of this committee, improved communication between stakeholders. Communication between stakeholders turned out to be a key element, which, ultimately, improved the outcomes of this pilot project.

Does a catch-quota scheme influence fishing behavior?

This study does not give a clear answer to the question whether a catch-quota scheme causes a reduction in cod discards. Comparisons with the DCF monitoring program and the self-sampling program do not give an indication pointing in that direction. Discard percentages of cod were not consistently lower on vessel participating in the catch-quota scheme (figure 9). Based on these results it could be concluded that there was no incentive for the fishers to change their behavior and avoiding undersized cod. However, such a conclusion is based on five vessels only, and therefore, it is suggested to not over-interpret the data. The five fishers did not change their strategy under the catch-quota regime and continued doing what they were always doing. Nevertheless, it should be considered that the DCF program is designed to representatively sample scientific data on discards of all species from the most important fleet segments of the Netherlands; it is thus not designed to monitor and verify specifically cod catches under a catch-quota pilot study with a limited number of vessels. Therefore, data from the DCF program should be considered as reference points only. In contrast, the Dutch self-sampling program that was established within the framework of the Dutch Cod Recovery Plan, is specifically designed to monitor cod catches; hence, it can be considered a more adequate match for direct comparison with the cod discard rates of our pilot project. Although data of the self-sampling program is cross checked with observers, reliability of the data remains questionable. Within the context of the Cod Recovery Plan fishers have an incentive not to report all discards, since this possibly could intensify regulation around the cod fishery. Unlike an EM monitoring, observer cross-checking does not have the advantage of a 100% coverage and the ability to make a true random selection of cross checking logbooks afterwards and not considering observer effects or low sampling coverage (Benoit and Allard, 2009; Stanley et al., 2011).

The comparison of the market category distributions of cod landings between vessels under a catch-quota regime (EM on board) and vessels with a (normal) quota based on landings (no EM on board) (figure 10) did not reveal any obvious behavioral change . During the end of 2011 (4th quarter) and the beginning (1st quarter) of 2012, vessels without a catch-quota scheme had a relatively small proportion of the smallest, and least valuable, cod market category (35-46cm) compared to vessels with full catch documentation. This suggests a potential high-grading of vessels without full catch documentation (see

section 3.4.2). However, also here it needs to be stressed that these interpretations are based on a very low sample size of 3 CCTV vessels only versus 13 “normal-quota” vessels.

Outlook

The project has been continued; the second project phase started in August 2012. There is future potential that the data might expose a more definite behavioral change, when longer time-series of data from a catch-quota scheme can be compared and the number of participants increases. Possible high-grading during similar periods might then be revealed in annual repetitions.
For the second phase it should be taken into account that possible future restrictions of the number of sea-days may influence the behaviour of the participating vessels: in order to save days, fishermen are likely to spend less time looking for the most optimal fishing areas, resulting in catches with smaller fish and more discards (i.e. Dalskov and Kindt-Larsen, 2009). This may (partly) undo expected effects from vessels participating in the EM pilot study.

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

Report Number : C132/12
Project Number : 4301102402

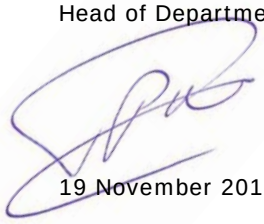
The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the fisheries research department of IMARES.

Approved: Dr. Christine Röckmann
Interdisciplinary marine scientist

Signature: 

Date: 19 November 2012

Approved: Dr. T. Bult
Head of Department

Signature: 

Date: 19 November 2012

Annex 1

Laatste wijziging: 10 augustus 2012 Durk W. van Tuinen Nederlandse Vissersbond

Instructies CCTV-systeem Kabeljauwvisserij

Deelnemers aan het project “Fully Documented Fisheries” dienen diverse handelingen te verrichten ten tijde van de duur van het project. Deze handelingen worden hieronder opgesomd en toegelicht.

1. Aanwezigheid installatie CCTV-systeem

Het CCTV-systeem zal door een installateur, die is aangewezen door de systeemeigenaar, worden geïnstalleerd. Installatie zal in overleg met de deelnemer plaatsvinden op een datum dat de deelnemer met het schip in de haven ligt en op een moment dat er geen of zo min mogelijk visdagen verloren gaan. De deelnemer dient tijdens de installatie aanwezig te zijn aan boord van het schip en zijn medewerking te verlenen aan de installatie, tenzij de installateur anders aangeeft.

2. Verwisselen harde schijf

De camerabeelden worden op een harde schijf opgeslagen en dienen elke maand te worden verwisseld door de deelnemer. De deelnemer is verplicht voor de eerste van de maand de harde schijf en het logboek (zie punt 3. Registratie kabeljauw en discards) bij IMARES af te geven of naar IMARES te versturen. IMARES zal, na het analyseren van de camerabeelden, de lege, harde schijf naar het opgegeven postadres van de deelnemer terugsturen.
De deelnemer dient te allen tijde voor aanvang van een nieuwe visreis een lege harde schijf aan boord te hebben.

3. Registratie kabeljauw en discards

Deelnemers aan het project worden geacht een registratie bij te houden van de maatse en ondermaatse kabeljauwvangst, waarbij zij de volgende handelingen dienen te verrichten:
1. De ondermaatse kabeljauw wordt per trek gewogen, discards per trek dienen in een mand zichtbaar voor de camera te worden getoond;
2. Voor de maatse kabeljauw geldt dat elke trek gewogen wordt;
3. Het nummer van het vaartuig (bijv. UK99), type tuig (bijv. OTB), maaswijdte (in mm), datum en de begintijd van de trek worden genoteerd in het Excel logboek dat door IMARES digitaal wordt aangeleverd aan de deelnemer;
4. Opgeviste kabeljauw wordt op de opvoerband langs een lengtemaat gehaald zodat middels de camerabeelden de lengte van de kabeljauw kan worden geschat (zie punt 4. Lengtemaat opvoerband);
5. De vangstgegevens worden door de deelnemer in het (bovengenoemde) Excel logboek geregistreerd dat door IMARES digitaal wordt aangeleverd aan de deelnemer;
6. Bij voorkeur wordt het formulier digitaal ingevuld en op wekelijkse basis digitaal verzonden naar dhr. E. van Helmond via edwin.vanhelmond@wur.nl. Indien het digitaal invullen en/of het digitaal verzenden niet mogelijk is, wordt het formulier per post naar IMARES verstuurd of bij IMARES IJmuiden afgegeven. Wanneer het Excel logboek niet is ingevuld kan bij uitzondering het reguliere logboek volstaan.

7. Het Exel logboek dient voor de eerste van de maand, en dus op maandelijkse basis, door IMARES te worden ontvangen.
8. Na installatie van de camera wordt er een week proefgedraaid met het systeem. De schipper dient na de eerste week de harde schijf te verwisselen en deze tezamen met het logboek bij IMARES af te geven. IMARES zal bekijken of de camera op een juiste wijze de gegevens registreert en of het logboek correct wordt ingevuld.

4. Lengtemaat opvoerband

Elke deelnemer dient een schaalverdeling aan te brengen op de opvoerband zodat bij de analyse van de camerabeelden beter ingeschat kan worden wat de maatklasse van de kabeljauw is. Hierover dient de deelnemer overleg te hebben met de installateur tijdens de installatie om te komen tot een correcte schaalverdeling, de schaalverdeling is in overleg met IMARES is vastgesteld.

5. Schoonhouden camera's en algemene werking

De deelnemer wordt geacht twee keer per dag te controleren of de camera's schoon zijn en dat het zicht niet belemmerd wordt door vuiligheid. Indien de camera's vuil zijn, dient de deelnemer deze schoon te maken. Controle van de werking van de camera's vindt plaats na afronding van de installatie door de installateur. Wanneer er een storing wordt gesignaleerd of vermoed door schipper en/of opvarenden dient er contact op te worden genomen met de daarvoor aangewezen organisatie (zie punt 7. Melding problemen).

6. Gebruik camera's

Het project streeft naar een volledig gedocumenteerde visserij. Dat betekent ook dat bij alle type visserijen waarbij kabeljauw kan worden gevangen de camera's dienen te worden gebruikt. Voor de garnalenvisserij wordt een uitzondering gemaakt. De compensaties in het project richten zich in eerste instantie op de Noordzee maar ook bij de visserij in Het Kanaal dienen de camera's te worden gebruikt. Deelnamecompensaties bestaan onder andere uit een verhoging van het individuele kabeljauw contingent en het terugverdienen van zeedagen.

7. Melding problemen

Het kan voorkomen dat er problemen optreden, zoals bij een camera die niet naar behoren werkt of dat de verwisseling van de harde schijf niet lukt. In dat geval dient per e-mail een bericht gestuurd te worden naar de installateur. De installatie wordt verricht door Piet Brouwer Elektrotechniek, waarbij de contactpersoon Jan Korf is (jkorf@pietbrouwer.nl). Daarnaast dient er te allen tijde een CC-bericht aan de projectbegeleiders gestuurd te worden. De projectbegeleiders zijn Durk W. van Tuinen van de Nederlandse Vissersbond (contact tel. 0527-698151 / email dwvantuinen@vissersbond.nl) en Geert Meun van VisNed (contact tel. 0527-684141 / email gmeun@visned.nl).

8. Aanlanding discards

Voor deelnemers aan het CCTV project geldt een aanlandingsplicht voor discards kabeljauw bij gebruik van 120 mm tuigen waarbij tuigen met een minimale maaswijdte van 120 mm onder vallen. Deze maatregel komt voort uit het "Cod Avoidance Plan" en dient overgenomen te worden om de korting van de zeedagen terug te verdienen. Het Ministerie van EL & I dient CCTV deelnemers ontheffing te verlenen om discards aan te landen. Wanneer u deze ontheffing nog niet

heeft ontvangen kunt u contact opnemen met de projectbegeleiding.
De discards kabeljauw dienen te worden aangeland bij een erkende visafslag, het afslagpersoneel en de buitendienstmedewerkers van het Productschap Vis zien erop toe dat de discards worden verwerkt.

9. Voorwaarden voor CCTV plaatsing

Onderstaande voorwaarden gelden voor installatie van een CCTV systeem en zijn opgesteld door de installateur. Aan onderstaande voorwaarden moet voldaan worden om het CCTV systeem te kunnen installeren:

- Voor de computer met harde schijf, dient een beschikbare ruimte aanwezig te zijn in het stuurhuis dashboard, de maten zijn B 210 x H 200 x D 330mm.
- Voor het beeldscherm, dient een beschikbare ruimte aanwezig te zijn het stuurhuis dashboard, de maten zijn B 420 x H 360 x D 330mm.
- Voor het toetsenbord, dient een beschikbare ruimte aanwezig te zijn het stuurhuis dashboard, de maten zijn B 380 x H 30 x D 160mm.
- De drie of vier camera's die geplaatst worden op het achterdek en verwerkingsdek, hiervoor dient de ruimte beschikbaar te zijn, de maten zijn B 200 x H 200 x D 200mm.
- Voor de hydrauliek drukgever, dient een aansluiting aanwezig te zijn in de persleiding van de nettenrol om deze te monteren.
- Voor de rotatie sensor nettenrol, dient een beschikbare ruimte aanwezig te zijn en ook voor de bekabeling op het achterdek.
- Voor de GPS antenne, dient een beschikbare ruimte aanwezig te zijn en ook voor de bekabeling naar de mast.
- Voor het leggen van de bekabeling dienen de doorvoeringen goed bereikbaar te zijn en is er ruimte beschikbaar om de kabels er door te trekken, ook gaan wij er vanuit dat de kabels op een eenvoudige manier te leggen zijn naar de desbetreffende componenten.
- Voor de computer en beeldscherm dient een 230 Volt wandcontactdoos aanwezig te zijn.
- Er wordt van u verwacht dat u aan boord bent tijdens montage van het systeem.
- Als het systeem eenmaal is geplaatst krijgt u een uitleg over de werking hiervan en hoe de harde schijf verwisseld moet worden en enkele praktische tips.
- Het schoonmaken van de cameralens is regelmatig noodzakelijk, één of meerdere keren per week. Hierbij zal het bij de ene camera meer nodig zijn als bij de andere.
- Het dagelijks controleren of de camera een goed beeld geeft is nodig, hierbij kan het ook voorkomen dat er door trilling of wat dan ook de camera niet goed weergeeft.
- Het gehele systeem is en blijft eigendom van de Nederlandse Vissersbond of VisNed en wordt gemonteerd met de daarbij geleverde componenten en materialen.

Annex 2

Deelnemerslijst CCTV

Project: Fully documentated Fisheries

Aanvragers: Nederlandse Vissersbond / Ursa Major Services BV en VisNed

KABELJAUWVISSERIJ

Kotter	Visserij	Naam	Organisatie	Eigendom CCTV	Gevestigd	Deel	Interesse	Geldige overeenkomst	Geinstalleerd
GO 58	TR	De Visser	NVB	NVB	Moerdijk	II	ja	ja	ja
UK 153	TR	Van Sloot	NVB	NVB	Urk	II	ja	ja	ja
TH 5	TR	Bout	NVB	NVB	Tholen	II	ja	ja	ja
IJM 31	TR	Blokker	NVB	NVB	IJmuiden	II	ja	ja	ja
BR 7	TR	Praet	VISNED	VISNED	Breskens	II	ja	ja	ja
UK 112	TR	De Boer	VISNED	NVB	Urk	II	ja	ja	ja
UK 194	TR	Romkes	NVB	NVB	Urk	II	ja	ja	op 9-11-2012 afgerond
UK 224	TR	De Boer	VISNED	NVB	Urk	II	ja	ja	ja
UK 37	TR	Romkes	VISNED	VISNED	Urk	I	ja	ja	ja
UK 24	TR	Romkes	VISNED	VISNED	Urk	I	ja	ja	ja
UK 22	TR	Romkes	VISNED	VISNED	Urk	I	ja	ja	ja
UK 135	TR	Pasterkam	VISNED	VISNED	Urk	I	ja	ja	ja
IJM 8	TR	De Visser	NVB	?	IJmuiden	I	ja	ja	ja