Report on the German Catch Quota Management trial 2012- 2014

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Report

by

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1 Summary

The purpose of the German trial on fully documented fisheries is to evaluate and further develop possibilities for the reliable determination of discards by means of electronic monitoring, and to test the feasibility of a management approach using a reversal of the "burden of proof".

Germany started its first trial on fully documented fisheries in the North Sea with one vessel in 2011. Due to various complications the first trial in the North Sea was cancelled at the end of 2011, and the project was reorganized at the beginning of 2012.

From May 2012 on, two North Sea trawlers, NC302 Helgoland (in the later stage NC322 Helgoland) and NC315 Victoria, were equipped with a Remote Electronic Monitoring-System (REM-system) installed under supervision of the German Federal Thünen Institute of Baltic Sea Fisheries. In accordance with the European legislation for catch quota management trials for North Sea fisheries targeting cod, an additional cod quota was granted to the participating vessels.

Even with some technical and software issues, the utilized system was able to record fishing activities during the whole period. The linkage between sensor data and video footage provided substantially more accurate data about the fishing behavior than the electronic logbook (Elog). However, the logistic effort to receive the data from the vessels was high and the analysis of the REM data was very time consuming.

During the three years trial, the rate of unwanted cod bycatch ranged between 0.0 and 9.43 % of the cod catches of these vessels depending on the fishing ground and gear.

2 Introduction

The main regulatory measure in European fisheries management is a catch limit (total allowable catch, TAC). However, TACs usually do not limit catches but landings only, at least until a landing obligation is fully enforced. Landings and actual catches, i.e. removals from a specific stock, can therefore differ significantly. Science tried to determine the motives for discarding and the amount of discards by means of extensive sampling programs with observers. However, using observers is expensive and the sampling intensity is low. This results in a high uncertainty in the extrapolation of the landing statistics to total removals, which are the used in the annual stock assessments of ICES and the catch forecasts. To reduce the uncertainty of discard estimations and create the right incentives for the avoidance of unwanted bycatch, this study assesses to what extent and how successful landing quotas can be converted into catch quotas. The two participating North Sea trawlers register all cod caught and count it against the quotas; they have to stop all fishing activities with potential bycatches of North Sea code once the quota is exhausted. The two trawlers receive an additional quota (a fraction of the predicted discards) as an appropriate incentive to fully document their catch.

A cost-effective way to fully document the fishery activity and catch composition is the video recording by a Remote Electronic Monitoring System (REM-system). In various fisheries on Canada's west coast, the video

recording of the fishing operation for each vessel is required since 1999. In 2008, a Danish pilot study was initiated with a REM-system. The German trial uses the same REM-System constructed by the Canadian vendor Archipelago to verify the electronic logbook entries.

The REM-system contains a central control and recording unit, which is connected to four CCTV cameras. Additionally a GPS unit (for position and velocity determination) and a hydraulic pressure sensor, as well as a winch sensor are installed to record the fishing activities independently. All data are stored digitally on a sealed hard disk that can only be replaced by authorized personnel. The results of the Danish pilot study demonstrated that the REM-system is an effective way to collect data on fishing patterns and catch composition. At relatively low cost, a high sampling density can be achieved.

In October 2009, representatives of the Danish, German and Scottish Fisheries Ministries agreed on the implementation of an extended pilot study for cod fisheries in the North and Baltic Seas.

In early 2011, NC315 Victoria, a North Sea trawler, was equipped with a REM-system installed under supervision of the German Federal Thünen Institute of Baltic Sea Fisheries (TI-OF). Due to various technical and administrative reasons, the study had to be restarted in 2012. The trial was then conducted with an additional North Sea trawler, NC302 Helgoland. The new German CQM trial is operating since the 28th of April 2012 (NC302 Helgoland; in the later stage NC322 Helgoland) and the 16th of May 2012 (NC315 Victoria).

2.1 German Catch Quota Management project

The purpose of the project is to evaluate and further develop possibilities for the determination of reliable information on discards by means of electronic monitoring, and to test the feasibility of a management approach using a reversal of the "burden of proof" and full documentation of catches.

2.2 Conditions

1. Participating vessels will receive a quota premium for cod in the North Sea and Skagerrak. This premium is calculated on the basis of the actually year's basis quota for cod and is, according to the regulation, limited to the lower of 30% of the basis quota for that vessel in this year, or 75% of the expected discards of this specific fishery. As example: For 2012, ICES expected discards in the order of 25.2% in addition to the predicted landings (8 kt discards compared to 31.8 kt landings). The quota premium will be reduced proportionally if part of the 2012 quota has already been taken at the time the project starts.

2. Vessels can only participate if there is a remote electronic monitoring system installed on-board, which permanently records position (in intervals to be determined, and derived parameters speed and heading), hydraulic pressure and winch activity. The system also records videos of the fishing and sorting processes whenever these take place. The system can be configured in a way that it switches off automatically

in defined harbors. The installed REM-system will be approved by the Thünen-Institute before a quota premium can be granted.

3. Under the CQM trial, the REM-system has to be operational for at least 90% of the fishing activity during the whole year. A participating vessel is not entitled to leave port without a functioning REM-system. If the REM-system fails at sea, fishing activity has to be stopped until the system has been repaired – unless the failure would not cause more than 10% unobserved fishing activity of that specific year.

4. It is the fisher's responsibility to record all fish which is not landed for human consumption: species composition and total weight by species. These data can be estimated and recorded in a separate document which is returned to the Thünen Institute of Baltic Sea Fisheries along with the hard disk. This document should provide "discards" on a haul-by-haul basis where possible, but at least per day.

5. Cod catches additionally have to be recorded in the logbook under remarks as "CCTV: XX kg catches not for hc (*human consumption*)". The total catch entered into the main field in the electronic logbook includes this fraction of catch not landed for human consumption. Data on cod catches form the basis of the report on compliance with CQM trial rules to the EU Commission. These cod bycatch data should also be recorded on a haul-by-haul basis, but other bycatch could be pooled until 10 kg are reached. For scientific purposes, the pooling should then be noted in the logbook.

6. Exempt from this obligation are only species which are bycaught in minimal amounts and for which the vessel has no quota, but which cannot be discarded in Norwegian waters (choke species).

7. It is also the fisher's responsibility to allow for an independent verification of the recordings of discarded fish/fish landed for other than human consumption purposes. This is ideally done by allowing the cameras to observe the sorting process. The fishery is responsible that these recordings can be used by the German Federal Office for Agriculture and Food (BLE) or the TI-OF, so individual fish must be visible on the tapes (view must not be blocked during the sorting, camera lens must be kept clean, etc.). If required, the speed of sorting and the conveyers must be reduced to document the bycatch. Bycatch collected from conveyers elsewhere can be put on the conveyer in front of the camera after the sorting process has been finished – this should be done in a way that allows the length measurement of most of the fish from the camera recordings.

8. Under the CQM trials, all catches of cod (incl. fish below MLS) are counted against the cod quota. The fishery has to stop once the cod quota (incl. quota premium) has been fully exhausted, unless it can be demonstrated that there is no bycatch of North Sea cod in the continued fishery.

9. The REM data are recorded on a hard disk; fishers notify Kutterfisch at the latest once the hard disk is filled by about 75% so that an exchange can be organized. TI-OF is responsible for organizing this exchange. In the first month of the trial, the hard disks should be exchanged more frequently (e.g. once a week) to be able

to identify and fix problems immediately. TI-OF can delegate the exchange procedure e.g. to local fishery inspectors.

10. The TI-OF receives logbooks, separate bycatch recordings and harddisks, and uses REM data to verify the statements of bycatch amount made by the fishery. TI-OF also provides an evaluation of data and a draft report to BLE. In this report, only data on cod catch and bycatch is considered, all other bycatch information is solely used for scientific purposes.

11. The fishery can decide to exit from the trials at any time. The quota premium will then be withdrawn, also retroactively. All data collected until this time then fall into the ownership of the fishery and can only be used with their consent.

2.3 Political and legal basis

In accordance with Article 7 in combination with Annex Ia of the Commission Regulation (EU) 44/2012 of 17 January 2012: ´…*Member States may grant an additional allocation to vessels flying its flag participating in trials on fully documented fisheries. The additional allocation shall not exceed an overall limit set out in Annex I as a percentage of the quota allocated to that Member State*.` and the Council regulations 57/2011 Article 7, 39/2013 (8), 43/2014 (13).

2.4 Implementation in Germany

2.4.1 REM specifications

At the beginning of the German Trail, only the commercial vendor's remote electronic monitoring system of Archipelago Inc., BC, Canada, was eligible to conduct such trials. Each system is installed under supervision of TI-OF, which is also responsible for the initial evaluation of data collected during the trials. During the last years, different companies within Europe started to develop REM-systems. Therefore it could be assumed that in the near future different systems with individual pro and cons are available.

Data are recorded in compliance with the requirements set out in Article 7.2(a) of Regulation 43/2012: at a minimum frequency of 2 min^{-1}, the system records vessel ID and GPS position (from this information speed and heading can be accurately determined), as well as hydraulic pressure and movement of net drums (these two parameters allow a verification of all gear movements). In addition, an appropriate number of cameras records a video footage of all net handling and catch sorting activities on-board the vessel (activity detection by sensors plus a certain temporal delay after the net drums and hydraulic pumps are switched off, usually set to one hour). The number of cameras depends on the specific characteristics of the vessels and is determined by the Federal scientists observing the installation process in cooperation with technicians of the vendor. The aim is always to be able to monitor all critical spots especially with regard to the sorting of the catch and potential discarding.

All discards are separated from the landings, sorted and weighed. The fresh mass of discarded fish is noted in the logbook. During the evaluation of the recorded data, the mass of discarded fish during key sequences (such as the sorting process) will be determined. These results will then be compared to the logbook entries.

No vessel participating in the CQM trials will be allowed to leave port without fully functional REM-system. If there is an infringement of this rule observed, the vessel will be excluded from the trials and quota premiums are withdrawn. The same holds if the system fails at sea and is not repaired immediately. The responsibility for the appropriate functioning of the system rests with the master of the vessel and not with the agencies evaluating the data. This includes cleanliness of the camera lenses; the output of the REM-system (data recorded can be used for the purpose described) is the determining factor, not the physical presence of the system. The Archipelago system that has been proven to work under most conditions occurring in commercial fisheries, is fully automatic and tamper proof.

Once the electronic storage has been filled, the hard disk containing the data is exchanged by an authorized person (either the scientific institution or a fisheries inspector) and the information is evaluated. We aimed for an in-depth comparison of the recordings with the information provided in the logbook.

2.4.2 All catches of the stock concerned are counted against the vessel's allocation

Participating vessels have agreed to record all discards and to count all catches of the relevant species in the relevant area (here: cod caught from the North Sea, not stock as stock identification can usually not be done on-board a commercial vessel) against the vessel's quota. The comparison of catch mass determined from REM recordings with logbook information will ensure a reliable estimation of the amount of discarded fish and an adequate follow-up.

2.4.3 Monitoring and control

Compliance will be ensured by the system described above: By means of comparison of information recorded by the REM (which results in estimates of fresh mass of fish caught and discarded) and the entries in the electronic logbook.

Non-compliance is for the German participants of the CQM trials defined as

– a failure to record data during more than 10% of the time at sea, or more than 5% if the failure of the system falls into periods of sorting the catch, if the crew is responsible for the failure

– a difference between logbook records and estimated mass of the catch of the species in question of more than 10%, if the logbook records are the lower of the two estimates. 10% is the level of accuracy determined for the REM- system in earlier Danish trials.

In case of non-compliance, the vessel is excluded from the trial and the quota premium is withdrawn.

2.4.4 'Type of vessel'

Regulation 43/2012 requests the calculation of discards for a specific fishery to arrive at a maximum quota premium. The text of the regulation leaves some room for different interpretations. We assume, as specified in the previous year in Reg. 57/2011, that this calculation refers to discards expected for the actual year for which the quota premium is granted. This information is only available from the ICES stock assessment and varies largely between years (mostly depending on the strength of the incoming year class) and is not provided for different fleets. For example, for 2012 ICES expected cod discards in all North Sea fisheries to be 25.2% in addition to landings. For the purpose of calculating fleet-wise fractions of expected discards, one could therefore take the relative distribution of discards of certain species in the past into account and project this to the absolute expected discards of that species. This historic data is however mostly not available in highly disaggregated form.

Also, any more detailed calculation for individual métiers for individual nations and not across international fleets would touch upon the principle of relative stability, as those nations with fleets showing comparatively high discard rates (such as beam trawlers) would be entitled to receive a higher quota premium than those nations with fleets using light demersal gear.

Therefore, the German fleet fishing for cod in the North Sea was divided into passive and active gear. In 2010 for example, 7 vessels belonged to the passive segment, 49 vessels to the active segment. Data on discard fractions in these segments was obtained from regular scientific Data Collection Frame-work (DCF) at-sea sampling 2008-2010, and was made available to STECF subgroups (SGMOS 2004 and 2005) on mixed fisheries in the North Sea for 2009. From these data it is obvious that discards of cod in the "passive gear" segment in the North Sea are negligible (1,6% based on 1 sampled cruise in 2010). Therefore, 98.4% of the cod discards must be produced by the second segment, the various active gear. This figure can be used to estimate the total expected cod discard for 2012 (and following years) for this segment.

3 Methods

For the German trial on fully documented fisheries a video based REM-system was deployed on two participating vessels using active gear from 2012 to 2014. The fish stock concerned is the North Sea cod stock.

3.1 Participating vessel

The technical details of the participating vessels NC315 Victoria and NC302 Helgoland are given in Table 3.1. During the trial the new vessel NC322 Helgoland was built and replaced the old vessel NC302 Helgoland during 2013. NC315 Victoria and NC302 Helgoland/NC322 Helgoland are fishing in EU and Norwegian waters, home ports are Hanstholm (DK) and Thyborøn (DK), respectively. Catch quota for cod for 2012- 2014, including additional quota due to participation in the CQM trial project, are shown in Table 3.2.

Table 3.1. Description of the vessels participating in the German CQM trial.

Vessel name	Helgoland	Helgoland	Victoria
Registration No.	NC302	NC322	NC315
Type of vessel	Demersal Trawler	Demersal Trawler	Demersal Trawler
Building year	1985 (rebuilt 1998)	2012	2004
Length over all	30.28	35.90	37.05
BT	299 t	432 t	499 t
Engine power	415 kW	725 kW	700 kW

Table 3.2a. Catch quota for cod for the vessels NC302 Helgoland and NC315 Victoria 2012-2014.

	NC302/NC322 Helgoland		NC315 Victoria	
	North Sea (cod /2A3Ax4)	Skagerrak (cod/03AN)	North Sea (cod /2A3Ax4)	Skagerrak (cod/03AN)
quota 2012 (t)	857	19.7	425.8	37.6
total 2012 (t)	**876.7**		**463.4**	
quota 2013 (t)	784.6	21.3	395.3	21.3
total 2013 (t)	**805.9**		**416.6**	
quota 2014 (t)	810,3	19,6	500,7	29,3
total 2014 (t)	**829,9**		**530**	

3.2 Remote electronic monitoring system

The remote electronic monitoring system used for the German CQM trial was developed by Archipelago Marine Research Ltd. (Archipelago), Victoria, BC, Canada. The system was already successfully installed on different vessel types with different gears (McElderry et al., 2005; 2006; 2008).

Archipelago's electronic monitoring system contains up to four video cameras (CCTV, in a later version up to 8), gear sensors (hydraulic pressure transducer, photoelectric drum rotation sensor) and GPS mapping to record profiles of a vessels fishing activity at sea. An on-board control box equipped with Archipelago's monitoring software package records each of these inputs (EM Interpret Users Guide, 2011). REM sensor data and image recording are logged permanently at a minimum frequency of 2 min^{-1}. Thus, fishing activities and equipment usage (winches, pumps) are displayed in real time during the entire fishing activity and fish processing and simultaneously saved on removable hard disks with a capacity of 500 Gigabyte (Figure 3.1). Flexible settings allow the definition of non-fishing areas like ports, so that no images are recorded in the port.

The REM-system was installed on-board of the vessel Victoria by employees of Archipelago Marine Research Ltd. in December 2010, on-board of NC302 Helgoland by colleagues of DTU Aqua in April 2012, and, after its

replacement with a new vessel, by a technician on NC322 Helgoland in 2013. The REM-system is operating since the 28thof April 2012 on NC302 Helgoland, since 16th of May 2012 on NC315 Victoria, and since 4th of March 2013 on NC322 Helgoland.

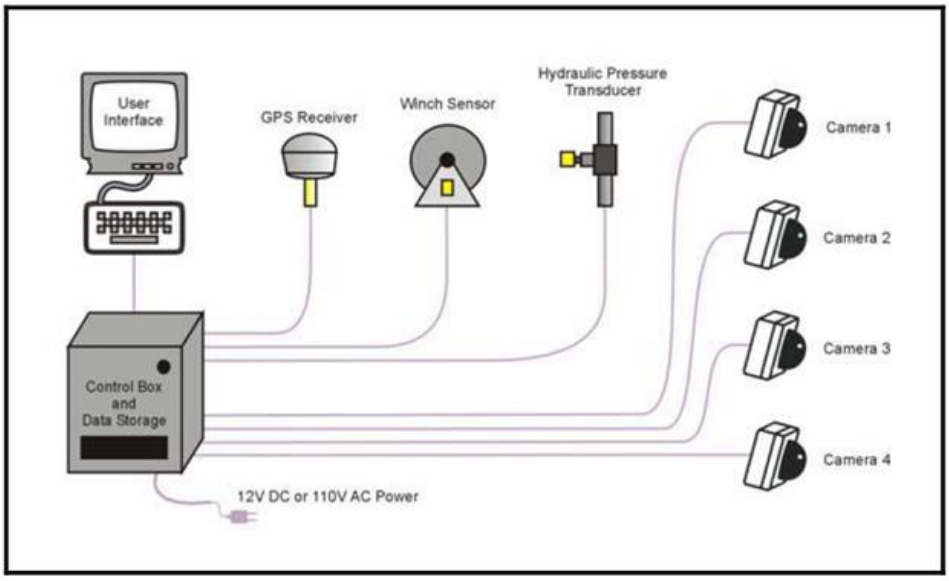

Figure 3.1.Schematic diagram of the electronic monitoring system (Archipelago).

3.3 Data analysis

3.3.1 Electronic logbook

To quantify the amount of cod fished during the trial period, employees of TI-OF got access to the electronic logbooks of both trawlers. The electronic logbook entries were analyzed for each fishing trip and fishing haul. Logbook entries included start date and duration of fishing trips carried out during the trial period, date and duration of individual fishing hauls, fishing location (ICES area), as well as the total weight and species-specific weight of catch. The total weight of discarded cod was reported in the logbook and noted as '*cod not for human consumption (NFHC)'.* Length measurements of discarded cod as well as weight of discards of other species were unfortunately not reported.

3.3.2 REM-system records

Sensor and image data collected with the REM-system were interpreted by TI-OF staff using software developed by Archipelago Marine Research Ltd (EM Interpret versions 1.1.0, 2.1,5).

Sensor data were used to validate fishing time and position in order to describe the spatio-temporal parameters for each fishing operation. The key trawler activities including transit, gear setting and gear retrieval were identified and compared with the logbook entries. Figure 3.2 shows a spatial plot and sensor time series illustrating part of a typical fishing trip.

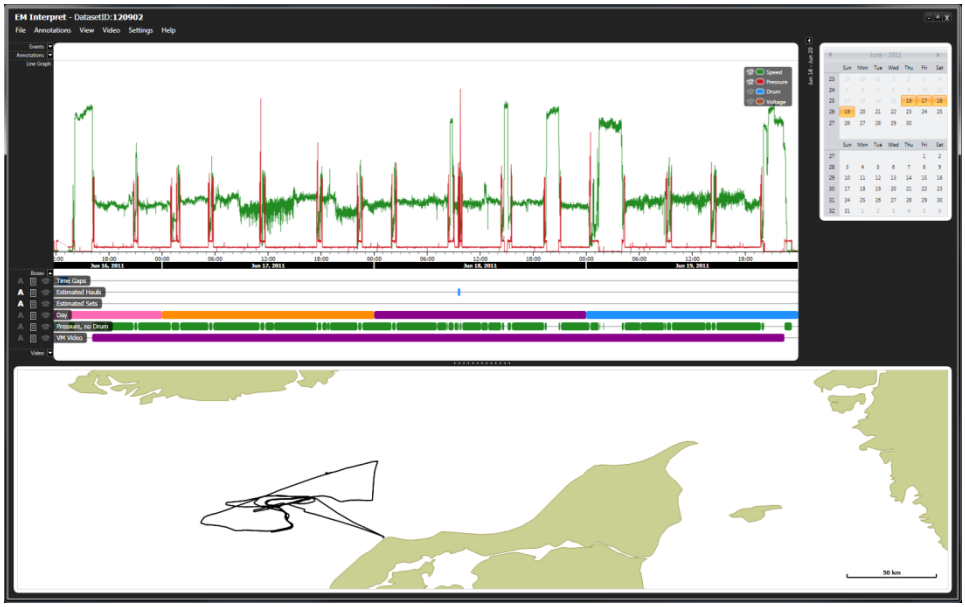

Figure 3.2.Example for sensor data time series and geographical position of a typical fishing trip.

The main objective of video image interpretation was to document all fishing events and fish processing by video sequences in order to validate the logbook entries of catches. Video image interpretation for key sequences (handling and sorting the catch) needs to be done by visual observation and is, thus, a very time consuming procedure. Therefore only randomly selected sequences were observed. Figures 3.3 and 3.4 give examples of the images that were evaluated.

Figure 3.3.Example for images recorded by four cameras on NC322 Helgoland.

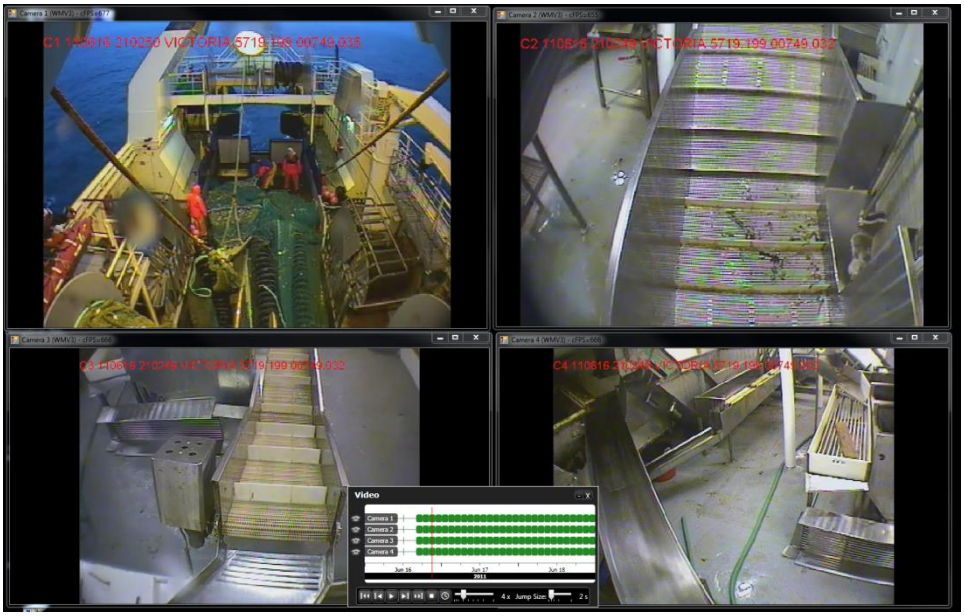

Figure 3.4.Example for images recorded by four cameras on NC315 Victoria.

4 Results 2012- 2014

ELOG

Both vessels were equipped with an electronic logbook system and at least the following information for each fishing operation was sent to the German Federal Office for Agriculture and Food: Date, time, position of setting and hauling, weight by species and total weight, total weight of cod '*not for human consumption*' (NFHC). The following chapter summarizes the most important data of the electronic logbook recorded during the trial.

NC302/NC322 Helgoland and NC315 Victoria showed very different fishing patterns. NC315 Victoria performed also pair trawling [PTB]. While NC302 Helgoland performed most hauls in the Northern North Sea with a "fly shooting seine [SSC]" (mesh size: 120 mm; length: 75 m), NC315 Victoria was mainly fishing in the Central or Northern North Sea with a "Bottom Otter Trawl [OTB]" (mesh size: 120 mm).

NC302/NC322 Helgoland performed a total of 844 hauls in 2012 (814 fishing hauls with a mean towing time of 2:11 hours and 30 "cleaning hauls" without any fish caught), 980 in 2013 (938 fishing hauls with a mean towing time of 2:05 hours and 42 cleaning hauls) and 1295 in 2014 (1253 fishing hauls, mean towing time 2:04 hours, 42 cleaning hauls)(Table 4.1). The hauls can be segmented in the following fishing métiers:

Table 4.1.NC302 (NC322) Helgoland: Number of performed fishing hauls in the different métiers in 2012 (01.05. - 16.12.12), 2013 (04.03.- 31.12.13) and 2014 (03.01.- 30.12.14).

FAO code	area	gear	number of fishing hauls		
			2012	2013	2014
27.3.a.n	Skagerrak	OTB	0	14	0
		SSC	25	21	27
27.4.a	Northern North Sea	OTB	14	47	66
		SSC	659	821	968
27.4.b	Central North Sea	OTB	7	2	18
		SSC	109	33	174
Cleaning hauls			*30*	*42*	*42*
		total	**844**	**980**	**1295**

NC 315 Victoria conducted a total of 524 hauls during 2012. Of these, 462 were fishing hauls with a mean towing time of 5:14 hours, two were cleaning hauls without any fish caught and 60 were pair trawls without any listed fish in the Elog (Table 4.2).

In 2013, NC315 Victoria performed a total of 787 hauls of which 690 were fishing hauls with listed fish in the Elog (mean towing time = 5:01 hours). Three otter trawls were cleaning hauls without any catch and 92 pair trawls did not list any catch in the Elog. For two hauls detailed information was not available.

In 2014, a total of 822 fishing hauls were performed (only otter trawls) of which 62 were cleaning hauls. The mean towing time was 4:50 hours.

Most pair trawls of NC315 Victoria were performed in the Div. IVb (92% of pair trawl hauls in 2012 and 90% of pair trawls in 2013). Only 8% (2012) and 5% (2013) of pair trawls were conducted in the Skagerrak and 5% in Div. IVa (only 2013) (Table 4.2).

Table 4.2. NC315 Victoria: Number of performed fishing hauls in the different métiers in 2012 (17.05. -29.11.12), 2013 (02.01.-18.11.13) and 2014 (03.01.-08.12.14).

FAO code	area	gear	number of fishing hauls		
			2012	2013	2014
27.3.a.n	Skagerrak	OTB	76	92	80
		PTB	7	6	0
		PTB without listed fish	5	5	0
27.4.a	Northern North Sea	OTB	1	158	174
		PTB	0	4	0
		PTB without listed fish	0	6	0
27.4.b	Central North Sea	OTB	292	313	506
		PTB	86	117	0
		PTB without listed fish	55	81	0
Cleaning hauls			*2*	*3*	*62*
No detailed information				*2*	
		total	**524**	**787**	**822**

In 2012, most frequently caught species were hake (*Merluccius merluccius)*, cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) (Figure 4.1). However, due to the different fished métiers there were differences in the species composition. NC302/NC322 Helgoland fished more hake than NC315 Victoria, while NC315 Victoria caught more haddock than NC302 Helgoland, for example.
In 2013 and 2014, saithe and cod were the most frequently caught species on both fishing vessels. On NC315 Victoria haddock was the third most frequently fished species, followed by hake (in 2013) and pollack (in 2014), while NC 302/NC322 Helgoland fished more hake (*Merluccius merluccius*) than haddock and pollack (Figure 4.1). A more detailed catch composition is attached in Appendix 1.

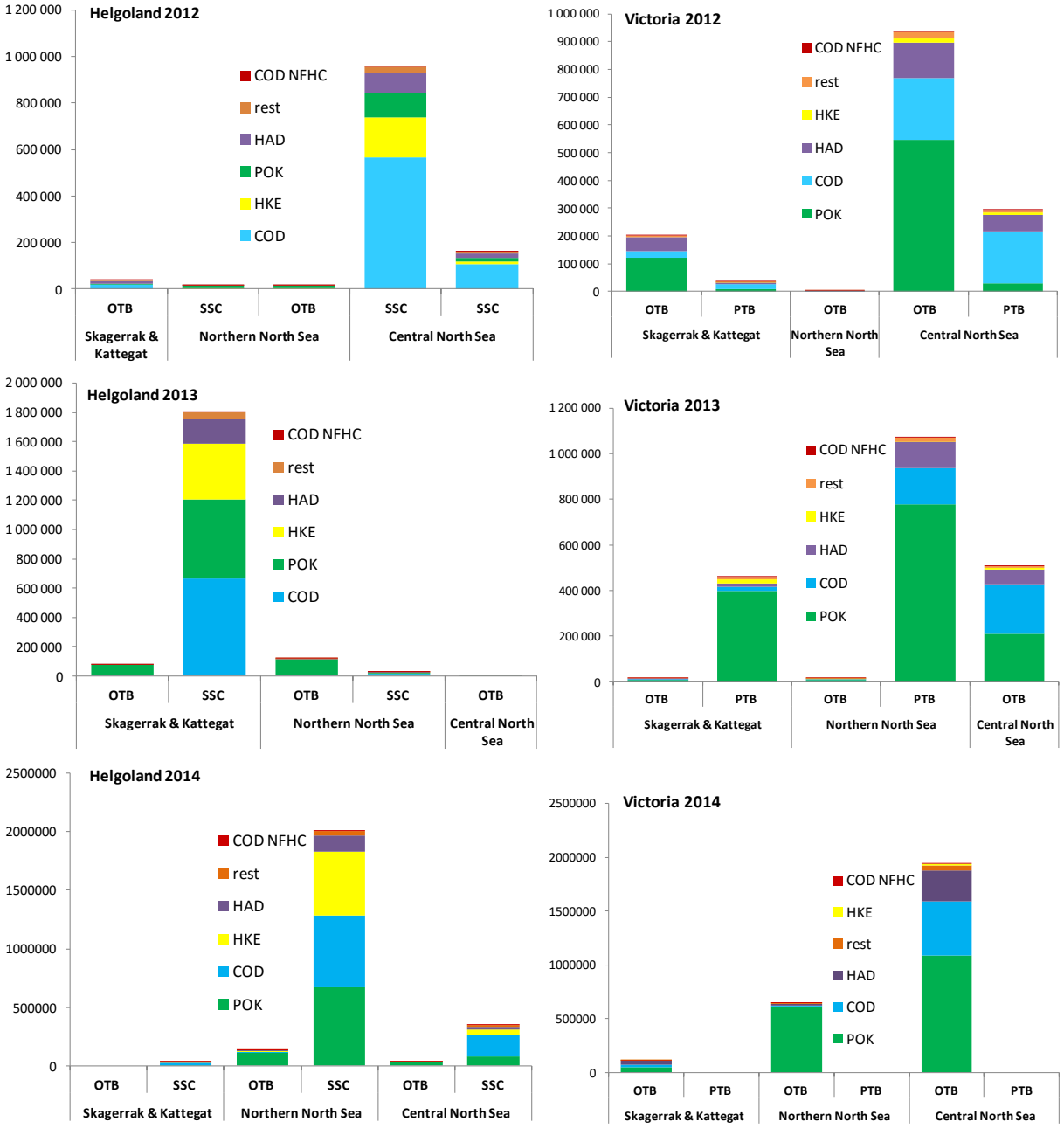

Figure 4.1. Landings of NC302 (NC322) Helgoland (left) and NC315 Victoria (right) from 2012-2014 for the different fishing métiers

REM records in comparison with the Elog

Fishing area

Figure 4.2 shows the fishing areas of NC302/NC322 Helgoland and NC315 Victoria, as derived from REM. The main operation area of both vessels is close to the Norwegian deep, in ICES-Divisions Iva, IVb and IIIa.

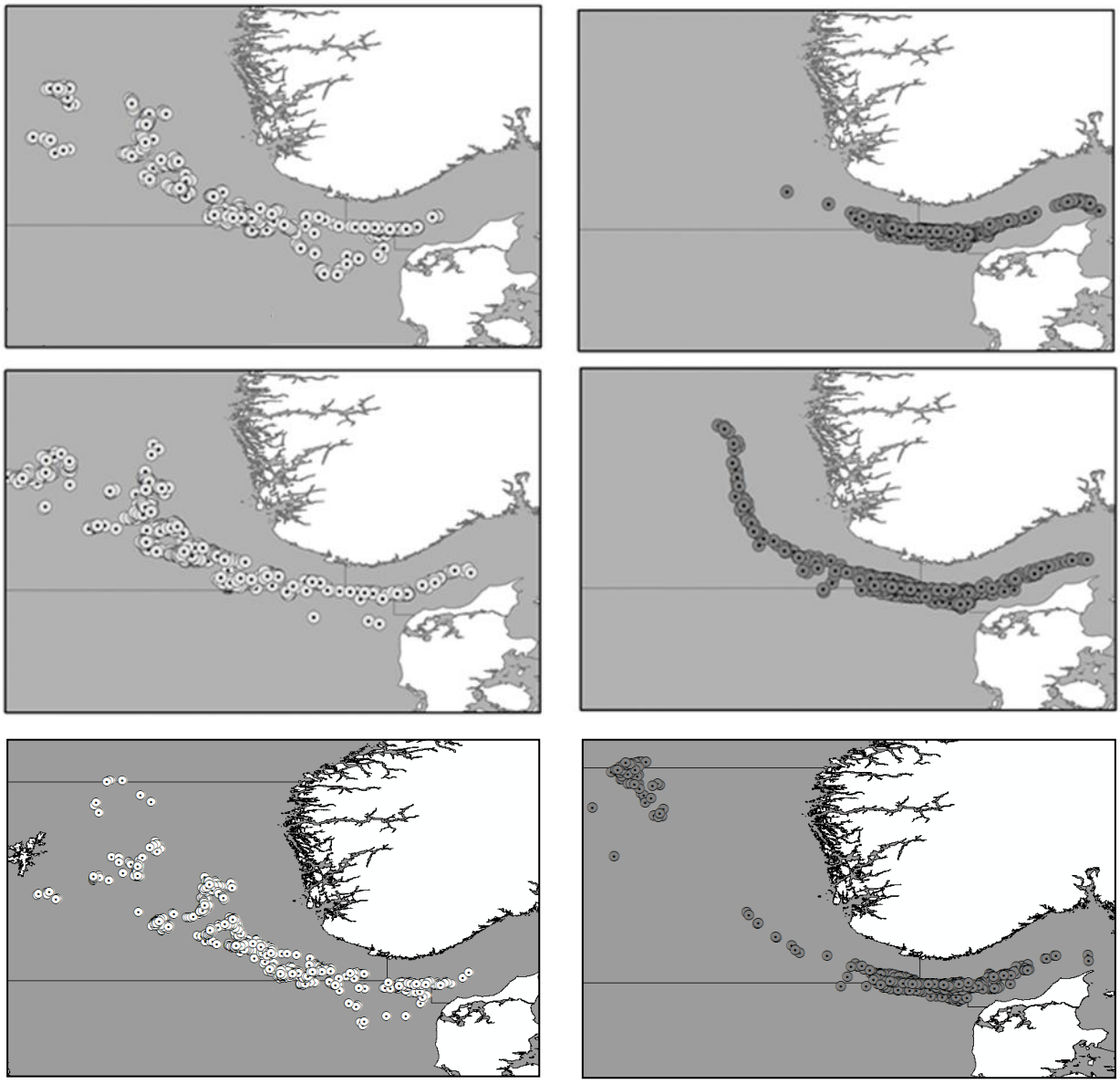

Figure 4.2. Fishing area of NC302/NC322 Helgoland (left figures) and NC315 Victoria (right figures). Each circle shows the end location of a haul recorded by the REM-system in 2012 (upper row), 2013 (middle row) and 2014 (lower row). Haul stations from Victoria in 2014 include only statins from January until mid of November.

Data from the REM-system are more precise than data from the Elog. While the exact fishing position is logged via the combination of hydraulic, video records and GPS in the REM-system, the Elog contains only imprecise

GPS position. A comparison between the Elog data and the REM data yielded that NC315 Victoria made more hauls in Div IVa than listed in the Elog.

NC 302/NC 322 Helgoland: fraction of coverage of REM recordings

2012

A total of 796 fishing hauls and 29 hauls without fish caught were recorded by the REM-system between 1st of May and 16th December 2012, resulting in a dataset of around 1385 hours of video recordings of fishing and around 786 hours of video recordings of fish processing. There was a significant failure of the whole system between the 23rd and the 26th of July and on the 20th and 28th of November. This failure led to the loss of 44 hours of video and sensor recordings during 20 hauls (19 fishing hauls and 1 haul without any caught fish). Apart from the failures of the total system, two camera breakdowns were observed. On the 29th of August camera 2 (Fig. 3.3) broke down for 40 minutes and on the 28th of November all cameras were off for 91 minutes.

In total (taking complete missing hauls and temporal camera failure into account), the REM-system failed to record 45 hours of fishing (2.4% of fishing time listed in the Elog). Unrecorded catch could only be derived from completely missing hauls in the REM. Taking only these complete missing hauls (N=20; 2.4% of total hauls recorded in the Elog) into account, 30,860 kg of fish (2.6% of total Elog fish catch) were not recorded by the REM, of which 24,905 kg were cod (3.6% of total Elog cod catches) and 131 kg cod *'not for human consumption'* (2.4% of total Elog cod nfhc) (Table 4.3a). This number is, however, an underestimation as unrecorded catch during temporal camera failure could not be included into the calculation.

In addition, in two cases (15th and 22nd of June 2012) fish catch was observed by the REM-system but not listed in the Elog, while in one case (17th of May 2012) fish was listed in the Elog but not observed by the REM-system.

2013

A total of 974 hauls (44 without catch) were recorded by the REM-system between the 4th of March and the 31st of December 2013, resulting in 3098 hours of video recordings (1921 hours during fishing and 1177 hours during fish processing).

20 hauls listed in the Elog were not recorded by the REM-system. 17 of these unrecorded hauls were due to a complete system failure between the 27th and the 30th of June, during which 34 fishing hours were not recorded. One haul (corresponding to 1.5 fishing hours) could not be recorded due to an error in the hydraulic and two hauls (corresponding to 4 fishing hours) were not recorded to unknown reasons.

In addition to the unrecorded hauls, the camera temporarily failed to record shorter sections (between 3 minutes and 5 hours) during several hauls, resulting in an additional 102 hours of unrecorded fishing (5.3% of fishing hours recorded by REM) and about 2 hours of unrecorded fish processing (0.2% of fish processing hours recorded by REM).

Thus, in total 142 fishing hours (7% of total Elog fishing hours) were not captured by the camera system. During these unrecorded hours, 28,302 kg of fish were caught (3.6% of total Elog catch) of which 12,630 kg were cod (5% of Elog cod) and 12 kg cod nfhc (1.4% of Elog cod nfhc) (Table 4.3a).
On the other hand, the REM-system recorded 14 hauls (1.4% of REM hauls) that were not listed in the Elog, 12 between the 1st and 5th of May, one on the 23rd of June and one on the 11th of July 2013.

2014

The REM-system recorded 1189 fishing hauls (35 without visible catch) between 3rd of January and 30th of December 2014 which corresponds to 3314 hours of video recordings (2075 during fishing and 1239 during fish processing).
112 Elog hauls were not recorded by REM. During these hauls, 257 hours of fishing and 8 hours of fish processing were not videotaped. 83 of the missing hauls were stored on a hard disk which was corrupted and could not be read out. An additional 39 hours were not recorded due to temporal camera failures.
During these 296 unrecorded hours, 292,895 kg of fish (11.5% of total Elog catch) were caught. 7000 kg of total catch were cod (0.8% of Elog cod catch) and 14 kg were cod nfhc (0.5% of Elog cod nfhc) (Table 4.3a).

NC 315 Victoria: Fraction of coverage of REM recordings

2012

Due to the performed pair trawl, data analysis was more complex compared to NC302 Helgoland. A total of 465 hauls (89% of hauls listed in the Elog) were recorded during the first trial period with REM, resulting in 2510 hours of video recordings during fishing and 659 hours during fish processing.
67 hauls listed in the Elog were not recorded by the REM-system, corresponding to 339 fishing hours.
Temporal camera failures led to the loss of 19 hours of video recordings during fishing.
During these failures, 71,434 kg of fish were caught (4.9% of total Elog catch). 43,445 kg of this catch was cod (9.7% of Elog cod catch) and 207 kg were cod nfhc (5.2% of Elog cod nfhc).
Four hauls recorded by REM were not listed in the Elog (19th and 26th of May, 29th of August and 21st of October) (Table 4.3b).

2013

Between the 2nd of January and the 18th of November 2013 a total of 621 hauls (75 without catch) were recorded by the REM-system on NC315 Victoria, resulting in 3359 hours of video recordings during fishing and 805 hours during fish processing (4161 hours in total).
26 hauls (120 fishing hours) listed in the Elog were not recorded by the REM-system. 144 hauls between the 23rd of February and the 1st of May 2013 were saved on an external hard disk that broke and began to burn at the Thünen Institute during the copy process. Data could therefore not be retrieved from the disc and therefore information about video and sensor recordings during this period was not available. The lost data correspond to 700 fishing hours.

The camera additionally failed to record shorter sections (between 3 and 461 minutes) of fishing activity in 654 occasions (489 and 165 times during fishing and fish processing, respectively). The duration of these temporal camera failures could only be estimated and is, especially for the fish processing, very uncertain. They were estimated to sum up about 1178 hours of unrecorded fishing (37.6% of fishing hours registered by Elog) and 119 hours of unrecorded fish processing. The reason for the failures was a wrong setting of the follow-up time of the camera records after the last activity of the hydraulic system. However, during that time all other sensor data were saved. Thünen Institute technicians investigated the reason for the irregular stops of camera recordings, which was not obvious as the settings were not changed. They found later that the record software contained an error and fixed it.

In total, excluding the missing data from the broken hard disk, the cameras of the REM-system failed to record 1298 fishing hours (41% of Elog fishing hours), including 26 complete hauls (4.0% of hauls listed in the Elog). Taking only complete missing hauls into account, this corresponds to 9209 kg of unrecorded catch (0.5% of catch listed in the Elog) of which 2805 kg were cod (0.7% of total Elog cod catches)and 16 kg cod *nfhc* (3.4% of total Elog cod *nfhc*) (Table 4.3b).

4 hauls captured by REM (0.6% of total REM hauls) were not listed in the Elog.

2014

In 2014 the REM-system recorded 760 hauls (3894 fishing hours and 1121 hours of fish processing) between the 3rd of January and 8th of December.

The REM-system failed to record 74 complete hauls (400 hours of fishing and 147 hours of fish processing).

Temporal camera failure occurred frequently and resulted in 1635 hours of unrecorded fishing. Summing these numbers up, 2035 hours of fishing activity (about 50% of fishing hours registered by Elog) were not recorded by the camera system.

During these missing hours, the REM-system failed to record 292,895 kg of fish (11.5% of total Elog catch) of which 7000 kg were cod (0.8% of Elog cod catch) and 14 kg were cod nfhc (0.5% of Elog cod nfhc.) (Table 4.3b).

Table 4.3.Data not recorded by the cameras of the REM (but listed in Elog) for a) NC302 (NC322) Helgoland and b) NC315 Victoria 2012 - 2014 (for Victoria 2013, missing data from broken hard disk are excluded)

a)

	NC 302 Helgoland							
	2012		2013		2014		**total**	
		% of Elog		% of Elog		% of Elog		% of Elog
No. of unrecorded hauls	20	2.4%	20	2.0%	112	8.7%	152	**4.9%**
No. of unrecorded fishing hours (complete + partial hauls)	45	2.4%	142	7%	296	11.1%	482	**7.4%**
Unrecorded catch all species in kg (complete hauls)	30 860	2.6%	28 302	3.6%	292 895	11.5%	352 057	**7.7%**
Unrecorded cod catch in kg (complete hauls)	24 905	3.6%	12 630	5.0%	7 000	0.8%	44 535	**2.5%**
Unrecorded cod nfhc catch in kg (complete hauls)	131	2.4%	12	1.4%	14	0.5%	157	**1.7%**

b)

	NC315 Victoria							
	2012		2013		2014		**total**	
		% of Elog		% of Elog		% of Elog		% of Elog
No. of unrecorded hauls	67	12.8%	26	4%	74	9.0%	167	**8.4%**
No. of unrecorded fishing hours (complete + partial hauls)	358	13.4%	1298	41%	2 035	50.9%	3 691	**37.7%**
Unrecorded catch all species in kg (complete hauls)	71 434	4.9%	9 209	0.5%	55 529	2.1%	136 172	**2.2%**
Unrecorded cod catch in kg (complete hauls)	43 445	9.7%	2 805	0.7%	25 677	4.7%	86 557	**6.1%**
Unrecorded cod nfhc catch in kg (complete hauls)	207	5.2%	16	3.4%	402	4.2%	1 252	**8.5%**

Summary fraction of coverage of REM recordings during the whole trial period (2012-2014)

Between 2012-2014 a total of 4.9% of hauls registered by Elog were not recorded the REM-system on NC302 & NC322 Helgoland. For NC315 Victoria this number was higher (8.4% unrecorded Elog hauls). Summing up fishing hours not recorded during these missing hauls and unrecorded fishing hours during temporary camera failures, these numbers increase significantly, especially in the case of NC315 Victoria where more than one-third of fishing time registered in the Elog was not recorded by REM. Most of the missing information is due to the frequent occurrence of temporary camera failures on this fishing vessel. In contrast, on NC302 & NC322 Helgoland only 7.4% of Elog fishing time was not captured by REM. Nevertheless, the amount of unrecorded catch (only complete fishing hauls not captured by REM) was higher for NC302 & NC322 Helgoland (7.7% of Elog total catch) than for NC315 Victoria (2.2% of total Elog hauls). This is due to the larger catch volumes of the first vessel during the unrecorded hauls. The percentage of unrecorded cod and cod nfhc catches, in turn, was higher on NC315 Victoria (6.1% of Elog cod and 8.5% of Elog cod nfhc catches) compared to 2.5% and 1.7% on NC302 & NC322 Helgoland, respectively.

Reliability of the REM-system

If we compare the fraction of REM-coverage of both vessels with the compliance criteria specified in section 2.4.III, we find that failure to record data was lower than 10% of the time at sea in the case of NC302 & NC322 Helgoland, but considerably higher than the tolerable failure rate on NC315 Victoria. The difference between logbook records and estimated mass of catch recorded by REM was well below the 10% on both vessels. Therefore, in summary, the REM-system delivered an appropriate coverage of fish catches on both fishing vessels and, on one vessel, also of fishing time. Temporal camera failures due to software errors on NC315 Victoria led to a high loss of video recordings. These errors need to be fixed in order to allow for an appropriate coverage of fishing time also on this vessel. There was no indication that the camera failures on any of the vessels was not entirely due to technical problems, i.e. the failures have not been caused by the crews of the vessels and could not be rectified by the crews.

Haul duration

NC302/NC322 Helgoland

There were significant differences between the haul duration indicated in the Elog and recorded by the REM-system. Towing times listed in the Elog were in most cases longer than the times recorded by REM (96% of hauls in 2012, 60% in 2013 and 86% in 2014), the mean towing time in the Elog being significantly higher than the mean towing time recorded by the REM-system (Fig.4.3). The maximum deviation was 85 minutes in 2012, 106 minutes in 2013 and 284 minutes in 2014. A comparison between Elog and REM shows that in 2012 only 2 hauls were listed in the Elog with the correct towing time. In 2013, the towing times listed in Elog and REM coincides for 28 hauls and in 2014 only for 9 hauls.

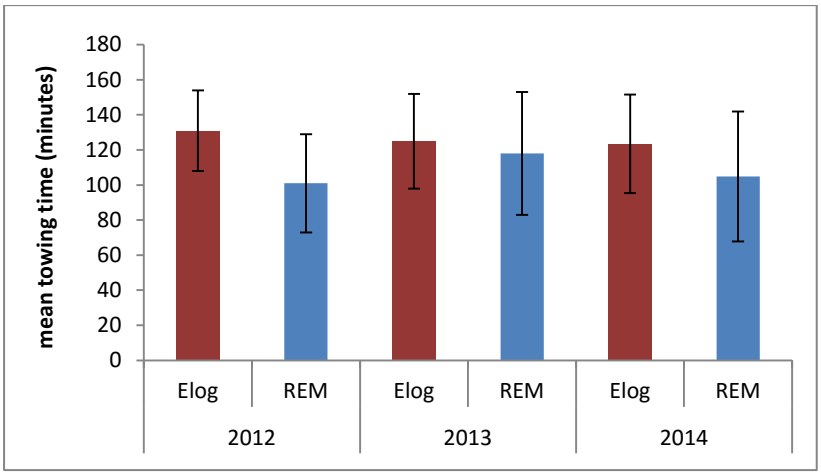

Fig. 4.3. Mean towing times of NC302 Helgoland listed by Elog and REM in 2012 -2014.

NC 315 Victoria

On NC 315 Victoria the contrary was the case. Towing times listed in the Elog were in most cases shorter than the times recorded by REM (84% in 2012, 95% in 2013 and 89% in 2015) (Fig. 4.4). The maximum towing time difference was 430 minutes in 2012, 559 minutes in 2013 and 420 minutes in 2014. Only one of the towing times indicated in Elog and REM matched in 2012, and none in 2013 and 2014.

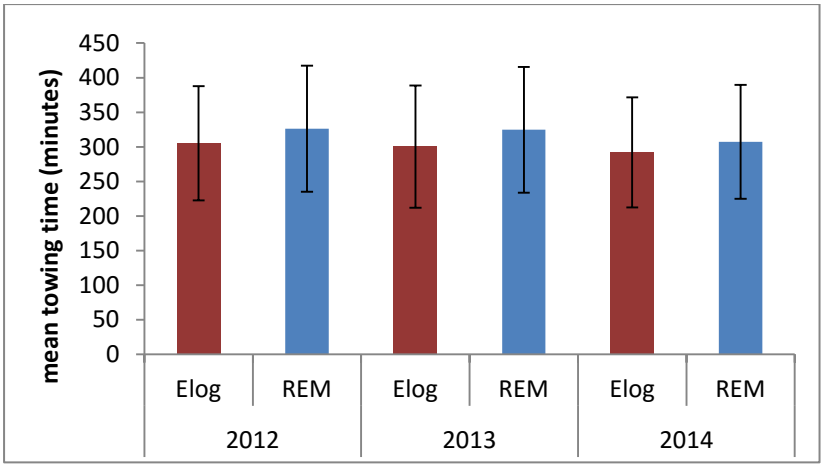

Fig. 4.4. Mean towing times of NC315Victoria listed by Elog and REM in 2012 - 2014.

By-Catch verification

To verify the Elog data, the Thünen Institute evaluated about 10 % of the video-taped hauls in detail, which corresponds to a total of 135 hauls (45 hauls of NC315 Victoria and 90 hauls of NC302/NC322 Helgoland) in 2012, comprising 24,229 minutes of video footage during fishing and 8082 minutes of footage during fish processing. In 2013, the effort was slightly higher. The observed 11 % of the video footage analysed consisted of 177 hauls (79 hauls of Victoria and 98 hauls of Helgoland) comprising of 37,360 minutes of fishing records and 14,296 minutes footage of fish processing. For 2014, around 17% of the REM video footage was evaluated by visual observation. This effort corresponded to 192 hauls on Helgoland (18,138 hours of fishing and 10,866 hours of fish processing) and 148 hauls on Victoria (40,881 fishing and 12,939 fish processing hours).

2012

The amount of cod bycatch observed via the REM-system was in accordance with the listed amount of cod bycatch from the skipper in the Elog in most cases (Helgoland 83 %; Victoria 71 %). On Helgoland 7 % and on Victoria 18 % of the Elog entries gave more cod bycatch (Helgoland: 2.8 ± 5.0 kg; Victoria: 5.8 ±7.9 kg) than observable via REM-system while in 8 % on Helgoland and 11 % on Victoria of the verified cases the observation with the REM-system showed more cod bycatch than listed in the Elog (Helgoland: 7.2 ±8.9kg; Victoria: 4.0 ±3.7 kg).

The application of a Shapiro-Wilk test showed that data were non-normally distributed ($p<0.050$). Therefore a statistical comparison between both groups (Elog and REM) was performed with a Rank sum test (Mann-Whitney) for each vessel. The results demonstrated that observed bycatch rates neither on Victoria nor on Helgoland differed significantly from the Elog entries by the skipper (Helgoland: $P = 0.603$; Victoria: $P = 0.856$).

2013

On Helgoland, 76 % of the bycatch data from the skipper in the Elog and the observed bycatch via REM were identical. 9 % of the Elog items gave a higher bycatch (mean 5.8 ±8.0 kg) than observable on the REM system while 16 % of the Elog entries showed lower bycatch (mean 9.25 ± 6.3 kg).

On Victoria, the bycatch in the Elog and the verified bycatch on REM recordings were identical in more than half of the cases (62 %). In 16 % of the bycatch cases observed by REM the biomass of cod was higher compared to the Elog entry (mean 2.7 kg ±1.7 kg) while 22 % of Elog entries showed higher bycatch (mean 5.2 ±3.8 kg) than observed via REM.

The Mann-Whitney test revealed that observed bycatch rates on Victoria and on Helgoland did not differ significantly from the Elog entries by the skipper (Helgoland: $P = 0.086$; Victoria: $P = 0.975$).

2014

On Helgoland, 88% of cod bycatch recorded by REM were listed identically in the Elog, on Victoria 74% of entries were in accordance. Cod bycatch reported in the Elog was higher than amounts estimated from REM in 6% of cases on Helgoland and 18% on Victoria, while cod bycatch as derived from REM recordings was higher

than the amount listed in Elog in 6% and 13% of cases. The results of the Mann-Whitney test demonstrated that observed bycatch rates neither on Victoria nor on Helgoland differed significantly from the Elog entries (Helgoland: P = 0.834; Victoria: P = 0.624).

Bycatch rates 2012-2014

The overall cod bycatch rates derived from the Elog are within a range of 0.00 and 9.43 % depending on the fishing area and gear (Tab. 4.4a, b). In most cases OTB produced more cod bycatch than PTB or SSC.

Table 4.4.Elog catch data of cod and '*cod not for human consumption*' from a) NC 302/322 Helgoland and b) NC315 Victoria during the CQM Trial

a) NC 302/322 Helgoland

		2012			2013			2014		
Fishing area	**Gear**	**cod catch (kg)**	**Cod nfhc catch (kg)**	**%**	**cod catch (kg)**	**Cod nfhc catch (kg)**	**%**	**cod catch (kg)**	**Cod nfhc catch (kg)**	**%**
27.3.a.n	OTB				1655	156	9.43			
	SSC	19 730	937	4.75	17885	213	1.19	1 035 861	3 714	0.36
27.3.a.n in total		**19 730**	**937**	**4.75**	**19 540**	**369**	**1.89**	**1 035 861**	**3 714**	**0.36**
27.4.a	OTB	1 440	22	1.53	6 230	152	2.44	1 075 426	3 999	0.37
	SSC	565 240	2 206	0.39	664 039	1 489	0.22	2 401 325	7 821	0.32
27.4.a in total		**566 680**	**2 228**	**0.39**	**670 269**	**1 641**	**0.24**	**3 476 751**	**11 820**	**0.34**
27.4.b	OTB	1 345	17	1.26	495			1 025 731	3 627	0.35
	SSC	108 825	2 192	2.01	12 455	166	1.33	1 198 106	4 353	0.36
27.4.b in total		**110 170**	**2 209**	**2.01**	**12 950**	**166**	**1.28**	2 223 837	**7 980**	**0.36**

b) NC315 Victoria

		2012			2013			2014		
Fishing area	**Gear**	**cod catch (kg)**	**cod nfhc catch (kg)**	**%**	**cod catch (kg)**	**cod nfhc catch (kg)**	**%**	**cod catch (kg)**	**cod nfhc catch (kg)**	**%**
27.3.a.n	OTB	21 632	953	4.41	19 428	604	3.11	1 366		0.00
	PTB	16 865	217	1.29	3 005	50	1.66			
27.3.a.n in total		**38 497**	**1 170**	**3.04**	**22 433**	**654**	**2.92**	1 366		**0.00**
27.4.a	OTB	720	17	2.36	20 060	404	2.01	1 100 001	19 400	1.76
	PTB				4 320	26	0.60			
27.4.a in total		**720**	**17**	**2.36**	**24 380**	**430**	**1.76**	**1 100 001**	**19 400**	**1.76**
27.4.b	OTB	222 051	2 076	0.93	159 113	1 737	1.09	1 540 285	24 932	1.62
	PTB	187 614	718	0.38	218 940	1 000	0.46			
27.4.b in total		**409 665**	**2 794**	**0.68**	**378 053**	**2 737**	**0.72**	**1 540 285**	**24 932**	**1.62**

One observer trip on NC 315 Victoria was available in 2012 to verify the REM and Elog data. The observed discard proportion of cod was 0.3% for the Skagerrak & Kattegat (IIIa) and 0.9% for the Central North Sea (IVb).

5 Outlook& Conclusion

The procedure of analyzing the REM data and to compare the results with the Elog records is very time consuming. This is due to two different time intensive processes: Firstly, due to a lack of an export function in the German Elog system, Elog data need to be copied into a data sheet, which takes about 2 minutes/haul. Secondly, the procedure to flag the fishing activities on the vessel in the Archipelago software EMI Interpret 2.0 is very labor-intensive, although the system has the function to start the videos automatically when fishing begins. To gain the meta data, the flagging of shooting and retrieving of the gear, as well as of the fish processing has to be done manually by using the software and observing the video footage. This process takes another 2 minutes/event. After the described procedure the validation can begin. This validation takes even longer. A person has to watch the whole video footage for each of the four cameras.

Paragraph 3 of the definitions of the project conditions defined that the REM-system has to be operational for at least 90 % of the fishing activity during the whole year. During the trial, we realized that it is unknot entirely clear if "operational" means that *all* sensors must be operational or whether individual sensor or camera failures would not accounted for. In this case, we refer to the whole system, and individual sensor or camera failures did not mean that the REM-system was not operational. In addition, the 90 % operational status refers to the vessel activity over the whole year, which means that the estimation of the percentage of system failures could only be conducted at the end of the year and not during the course of the trial.

Furthermore, the most important video material to verify the catch composition entries of the Elog are the records of the fish processing. If the cameras broke down in that area, the end of the fish processing could not be determined, and the operational time in that case could not be calculated. In this case we tried to estimate the end of the fish processing which implies a high level of uncertainty.

Finally we had some logistical and technical problems related to the exchange of the storage media. The vessels were located in Hanstholm and Thyborøn and consequently the way of the harddisks from the vessel to the Thünen Institute was long and took sometimes some weeks. Therefore the footage, which was evaluated by the Thünen Institute, was sometime several months old, and problems which were observed could not be solved in real time. Technical problems obviously occured on NC315 Victoria, where we observed a lot of camera failures. Even several visits of technical personnel on the vessel were unsuccessful, until early 2016.

Acknowledgement

We would like to thank Kai-Arne Schmidt, CEO of the Kutterfisch PO, skippers and crew onboard of NC302 & NC322 “Helgoland” and NC315 “Victoria” for their cooperation, Ulf Böttcher, and colleagues at DTU Aqua for the technical service, the Danish AgriFish Agency, especially Søren Palle Jensen for coordinating the exchange of the hard disks in Northern Denmark, Vincent Siebert for analysing the video footage and validating the by-catch records, and Kay Panten and Eckhard Leu for providing observer data for 2012.

6 References

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Appendix 1

Detailed catch composition (in kg) derived from the E-log of a) NC302/322 Helgoland and b) NC315 Victoria2012-2014.

FAO Code for Area: 27.3.a.n: Skagerrak; 27.4.a: Northern North Sea; 27.4.b: Central North Sea

Gears: OTB: Bottom Otter Trawl (Mesh size 120 mm); SSC: fly shooting seine (Mesh size 120 mm);

Species: ANF: *Lophius piscatorius*; CAT: *Anarhichas spp*.; COD: *Gadus morhua (*nfhc: not for human consumption*)*; COE: *Conger conger;* DAB: *Limanda limanda*; GUX: *Triglidae*; HAD: *Melanogrammus aeglefinus*; HAL: *Hippoglossus hippoglossus*; HKE: *Merluccius merluccius*; HOM: *Trachurus trachurus*; LEM: *Microstomus kitt*; LEZ: *Lepidorhombus* spp.; LIN: *Molva molva*; MEG: *Lepidorhombus whiffiagonis*; PLA: *Hippoglossoides platessoides*, PLE: *Pleuronectes platessa*; POK: *Pollachius virens*; POL: *Pollachius pollachius*; RED: *Sebastes spp*., SAR: *Sarotherodon galilaeus*; SQU: *Loliginidae*, *Ommastrephidae*; SRA: *Prionotus spp*.; TUR: *Psetta maxima*; USK: *Brosme brosme*; WHG: *Merlangius merlangus*; WIT: *Glyptocephalus cynoglossus*;

a) NC302/322 Helgoland

2012

FAO code	Gear	ANF	CAT	COD	COD nfhc	DAB	GUX	HAD	HAL	HKE	LEM	LIN	MEG	PLE	POK	POL	SAR	SQU	SRA	USK	WHG	WIT
27.3.a.n	SSC	35		19 730	937	1 660		13 065			360	135		1 470	1 245	25		80	1 245		60	
27.4.a	OTB	65	30	1 440	22			465		1 615		250			12 355	290					90	
	SSC	1 850	1 660	565 240	2 206	130	2 355	88 290	1 093	174 965	800	7 287	140	2 945	100 775	6 470	60	160	300	220	1 800	35
27.4.b	OTB	35	30	1 345	17			35		960		930			13 540	30					35	
	SSC	305	160	108 825	2 192	295	680	22 760	50	9 480	420	800		1 405	13 655	990				50	25	

2013

FAO code	Gear	ANF	CAT	COD	COD nfhc	DAB	HAD	HAL	HKE	HOM	LEM	LEZ	LIN	PLE	POK	POL	SQU	TUR	USK	WHG	WIT
27.3.a.n	OTB			1 655	156		1 815	10							70 270					35	
	SSC	7	21	17 885	213	10	14 600				9		89	4	10 575	260	10		16	46	
27.4.a	OTB	380	198	6230	152		4 364	44	265		30		560		104 156	490			185	145	
	SSC	1 581	2 999	66 4039	1 489	85	169 837	1 449	381 441	130	1 376	102	11 440	4 530	543 900	12 537	85	93	199	8 530	32
27.4.b	OTB			495		10	245						25	10	170						
	SSC	102	163	12 455	166	5	3 080	56	5 720		157		28	229	4 220	225		24		135	

2014

FAO Code	Gear	ANF	BLL	CAT	COD	COD nfhc	DAB	GUX	HAD	HAL	HKE	LEM	LEZ	LIN	MAC	MEG	PLE	POK	POL	SQU	TUR	USK	WHG	WIT
27.3.a.n	SSC	3407	31	3489	1035861	3714	961	10	209750	1127	643846	1634	590	18192	120	4	4391	982789	21701	512	76	1022	9728	118
27.4.a	OTB	3 583	31	3 522	1 075 426	3 999	961	14	214 580	1 132	643 927	1649	590	18459	120	516	4391	1021364	22711	528	79	1044	9754	134
	SSC	7 301	66	8 350	2 401 325	7 821	1 529	535	493 250	3 216	1 720 452	3579	1155	37025	273	1052	8914	2189081	52572	1192	169	2175	23231	241
27.4.b	OTB	3 337	31	3 489	1 025 731	3 627	961	1 582	208 150	1 127	643 806	1634	590	18192	120	2236	4391	970379	21466	512	76	1022	9703	118
	SSC	3 701	40	3 888	1 198 106	4 353	1 229	3 823	230 730	1 167	660 052	1915	596	19554	149	2748	5400	1035591	23136	533	86	1060	9874	139

b) NC315 Victoria

2012

FAO code	Gear	ANF	CAT	COD	COD nfhc	HAD	HAL	HKE	LEM	LIN	PLE	POK	POL	SQU	TUR	USK	WHG
27.3.a.n	OTB		222	21632	953	52582			64	14	969	122937	1783				18
	PTB			16865	217	6360		480				9474	730				
27.4.a	OTB			720	17	2254					25	48					
27.4.b	OTB	2034	1896	222051	2 076	129525	194	13132	1800	3612	1273	546212	13948	567	95	84	427
	PTB	115	731	187614	718	59510	238	6347	637	348	1147	30115	6736		12		37

2013

FAO code	Gear	ANF	BLL	CAT	COD	COD nfhc	HAD	HAL	HKE	LEM	LIN	PLE	POK	POL	SQU	TUR	USK	WHG	WIT
27.3.a.n	OTB	73		200	19428	604	27611	63		177	113	270	305813	768		4		62	31
27.3.a.n	PTB	36		47	3005	50	3459			4	27	37	7066	172					
27.4.a	OTB	946		458	20060	404	11628	584	20984	42	3922	18	397105	2683	106	16	176	2277	13
27.4.a	PTB			30	4320	26	1932	26	1980		48	84	5712	180					
27.4.b	OTB	1314		1650	159113	1 737	115 832	402	1809	1652	2950	1388	776086	7011	52	85	104	1926	
27.4.b	PTB	131	4	2219	218940	1 000	66061	308	5550	269	826	946	207779	3354			36	76	174

2014

FAO Area	Gear	ANF	BLL	CAT	COD	COD nfhc	COE	HAD	HAL	HKE	LEM	LIN	PLA	PLE	POK	POL	RED	SQU	TUR	USK	WHG	WIT
27.3.a.n	OTB	1 057 332	60	371	1 366		61	3 136 516	29 138	3 556	36 910	1 303	810	11 054	315	637 891	10 684	9 971	16 080	494		9 431
27.4.a	OTB	9 999	0	11 377	1 100 001	19 400	60	657 193	1 398	30 554	10 042	12 639	61	16 183	3 516 130	40 187	494	377	326	827	3 677	1 625
27.4.b	OTB	10 699	0	15 163	1 540 285	24 932	81	920 072	1 838	40 861	13 622	14 225	61	42 893	3 788 363	50 259	494	423	466	860	4 184	1 833