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POSTADRES
Postbus 68
1970 AB IJmuiden

BEZOEKADRES
Haringkade 1
1976 CP IJmuiden

INTERNET
www.wageningenUR.nl/imares

KvK NUMMER
09098104

CONTACTPERSOON
Edwin van Helmond

TELEFOON
+31(0)317 487171

E-MAIL
edwin.vanhelmond@wur.nl

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Europees Visserijfonds: Investering in duurzame visserij

The efficacy of electronic monitoring in bottom trawling: a pilot study in the Dutch pulse trawl fishery for sole, *Solea solea*. (DRAFT).

A.T.M. van Helmond, C. Chen, J.J. Poos

Introduction

A phased implementation of the obligation to fully report and land all catches (EU, 2013) is planned in the context of the European Common Fisheries Policy (Holden, 1994). A full implementation of the landing obligation will be in place for all European fisheries by January 2019. For several fisheries on demersal species, the implementation starts January 2016, as is the case for the pulse and beam trawl fishery for sole, *Solea solea*, in the North Sea.

Implementing the landing obligation requires that the complete catch (landings and discards) is reported and deducted from the available quota. Electronic monitoring (EM) is often presented as one of the solutions to fully document catches (Mangi *et al.*, 2013). EM systems consist of GPS, cameras, and sensors for measuring force on the tow cables and net drum rotation, all connected to a control box (McElderry *et al.*, 2003). These systems allow full coverage of a vessel's fishing activity and the monitoring of all catches using video technology (McElderry *et al.*, 2003; Ames *et al.*, 2007; Stanley *et al.*, 2009, 2011; Kindt-Larsen *et al.*, 2011). However, recording the catch of undersized sole with EM in a beam trawl catch will be challenging. Due to the large volume of bycatch in the beam trawl fishery (Catchpole *et al.*, 2008, Ulleweit *et al.*, 2010), it will be difficult to observe relatively small specimen, like undersized sole, through video review. Previous studies already described the limitations of EM, when catch volumes are large and specimens of fish are small and similar looking (Ruiz *et al.*, 2015; van Helmond *et al.*, 2015).

This pilot study was initiated in at the end of 2014 as a collaboration between the Dutch Ministry of Economic Affairs and the Dutch National Federation of Fishermen's Organisations. The aim of this study is to evaluate the efficacy of EM for undersized sole on the Dutch beam trawl fishery. We use two pulse trawlers in this case study to test the hypothesis that catches of undersized sole (individuals with a total body length below 24 cm) are difficult to detect with video monitoring in catches of bottom trawl fisheries and the current routines used on board to sort the catch. In addition, we tested if using a method or protocol to allow better recording of individual fish, would improve the efficacy of video monitoring. Pulse trawling is a variant of beam trawling, that makes use of an electrical pulsating field, as an alternative to tickler chains, to stimulate flat fish, to leave the sea bottom sediment. Pulse trawling is used to a growing extent in the Dutch flatfish beam trawl fleet, and considered as a promising alternative to conventional chain beam trawling (van Marlen *et al.*, 2014).

To test the first hypothesis, the efficacy of EM for undersized sole in the beam trawl fishery, we compared logbook with video records for undersized sole in weight and numbers. There was no interference on the routines on board and the setup of the camera system created the best overview possible with six cameras. To test the second hypothesis, we created a situation of improved video monitoring. Fishers were asked to count the undersized sole and keep them separate during the process of sorting the catch and display all individuals on the sorting belt in front of the cameras after the rest of the catch was processed. To evaluate the efficacy of EM in the different situations, estimating in weight, number, and the separate display of undersized sole, we compared logbook and video records for two aspects: i) systematic differences between logbook and video records and video observations, and ii) correlation between logbook records and video observations. The differences in results substantiate the efficacy of EM between the different situations.

Reliable methods to accurately monitor catches on board commercial fishing vessels are a crucial element of the implementation of the landing obligation. A substantial part of the flat fish stocks in Northern Europe are fish with beam trawlers or gears with comparable volumes of bycatch (Catchpole *et al.*, 2008; Uhlmann *et al.*, 2014). Not being able to meet the catch monitoring standards to record all catches accurately, and, consequently, not being able to monitor compliance of fishers with the landings obligation, will be a liability for fisheries management. This study gives an insight in the possibilities of using EM on board bottom trawlers within the context of the landings obligation.

Methods

Data collection

Two vessels participated in the pilot study on a voluntary basis. Both vessels started monitoring at the beginning of 2015, one vessel participated for 35 weeks the other vessel participated for 42 weeks. During all these weeks for every haul the catch of undersized sole was registered in logbooks. Both vessels always used pulse trawl gear during the pilot study.

The vessels were fitted with EM systems consisting of GPS, six closed circuit television (cctv) cameras, and sensors for measuring force on the tow cables and net drum rotation. All sensors and cameras were connected to a control box with exchangeable hard drives for data storage (McElderry et al., 2003; Kindt-Larsen et al., 2011). The sensors were used to trigger the control box to start video recording during fishing operations. The cameras recorded overhead views of the working deck and catch-handling areas, while fishing, hauling, and processing the catches (Figure x). Sensor and GPS data were recorded continuously while at sea. The EM system and the video analysis software were developed by Archipelago Marine Research Ltd. The installation costs per vessel were ca. 10 thousand euro, and the annual running costs per vessel were ca. 4 thousand euro. Deploying EM on board was compensated with "scientific quota", this is quota that is made available to compensate for potential revenue losses for vessels that participate in research projects.

Fishers recorded both weight and total numbers of undersized sole in logbooks. Scales are used to estimate catch weights on board the vessels. In addition, fishers were asked to count the undersized sole and keep them separate during the process of sorting the catch and display all individuals on the sorting belt in front of the cameras after the catch was processed (Figure xx). This gave the video reviewer the opportunity to count and record the undersized sole before it was discarded. Also, the video reviewer counted undersized sole while reviewing the footage of the sorting process on board. Fishers did not change their normal routines when sorting and processing the catch on board. To be able to compare logbook records with video observations in weight, the number of undersized sole counted by the video reviewer during the sorting process were converted to weights using a length-weight relationship. However, lengths of undersized sole caught by beam trawling are, in general, distributed between 17 and 24 cm (Ulleweit et al., 2010). Identifying length categories in such a small length range was not possible with the used camera set up, therefore, it was decided to give all undersized sole the same length, 20 cm, the midpoint of the length distribution between 17 cm and 24 cm (rounded to cm below). Numbers per length (all 20 cm) were converted to weights using a length–weight relationship of the form W = aLb, where W is the weight in grams and L is the length in cm. Parameter values were taken from (Coull et al., 1989), with a being 0.0036 and b being 3.3133.

A selection of the hauls was used for further analysis. This selection was made in a stepwise procedure, see also van Helmond *et al.* (2015). First step, all trips with video recordings were matched to logbooks from those trips. Not all trips could be matched and analysed. Because of missing EM data, due to technical failure, xx% of the trips could not be used for further analysis, and missing logbooks, xx% of the trips. As a result, xx% of the trips could be used for further analysis. In the second step, image quality was evaluated for each fishing day in those trips. For xx% of the fishing days, image quality was sufficient for video analysis, while xx% could not be used because of dirty lenses. In the third and final step, from the days with sufficient image quality, hauls were randomly selected for analysis.

Data analysis

The distribution of catches suggested that these are log-normally distributed. To correct for this in statistical tests that assume normality, a common logarithm transformation was done on all catch data.

The relationship between recordings of undersized sole in logbooks and video can be explored from two aspects: systematic differences and correlation. With the analyses for systematic differences, we studied whether video overestimates or underestimates catches of undersized sole relative to the logbook. On the other hand, correlation investigates how the recordings from video changes according to the logbook, or whether they follow a linear relationship. In the ideal situation, we would expect no systematic difference and high correlations between logbooks and videos recordings, see also van Helmond *et al*. (2015).

Systematic differences could derive from unintentional errors, possibly as a result of a specific setup flaw of the EM system, e.g. the inability to correctly estimate the catch of undersized sole from video. Systematic differences could also derive from participating fishers through under- (or over-) reporting catches of undersized sole compared to those observed on video. Since the two monitoring methods were tested in matched hauls, a straightforward way to quantitatively analyse the systematic difference is to apply a paired t-test on catch records between logbook and video per vessel.

The correlation between video and logbook recordings was calculated by the Pearson correlation coefficient (Pearson's r). Pearson's r specifies the linear dependence between log transformed video and logbook records, where 1 is a total positive correlation and 0 is no correlation.

(Preliminary) Results

(In this draft we only present results on comparisons of logbook and video records in numbers).

During the pilot study the two vessels completed 75 trips, from which, in total, 46 hauls were randomly selected for comparison with video data. From Figure 1 we see that vessel B has on average a larger number of undersized fish estimated by fisher, implying that these two vessels are quite different in terms of catch composition. Consequently, missing data from one vessel might limit our conclusion to all vessel types.

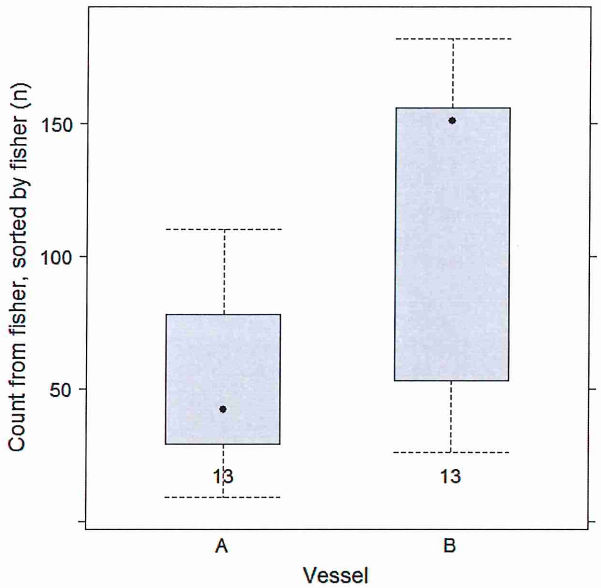

Figure 1. Total numbers of undersized sole recorded in the logbooks for vessel A and B.

Systematic differences and correlation

Recording in numbers

24 hauls were selected for comparison of logbook records with video observations in numbers: 13 hauls from vessel A and 13 hauls from vessel B. Recorded number of undersized sole in logbooks were compared with the number of video observations, based on reviewing the whole sorting process. The paired t-test shows that video review on average underestimate the number of undersized sole, compared to the logbook records ($p<0.01$, mean of the differences is 0.25). The Pearson correlation coefficient is 0.71 (95%CI: 0.45-0.86), indicating a moderate linear relationship between the two methods.

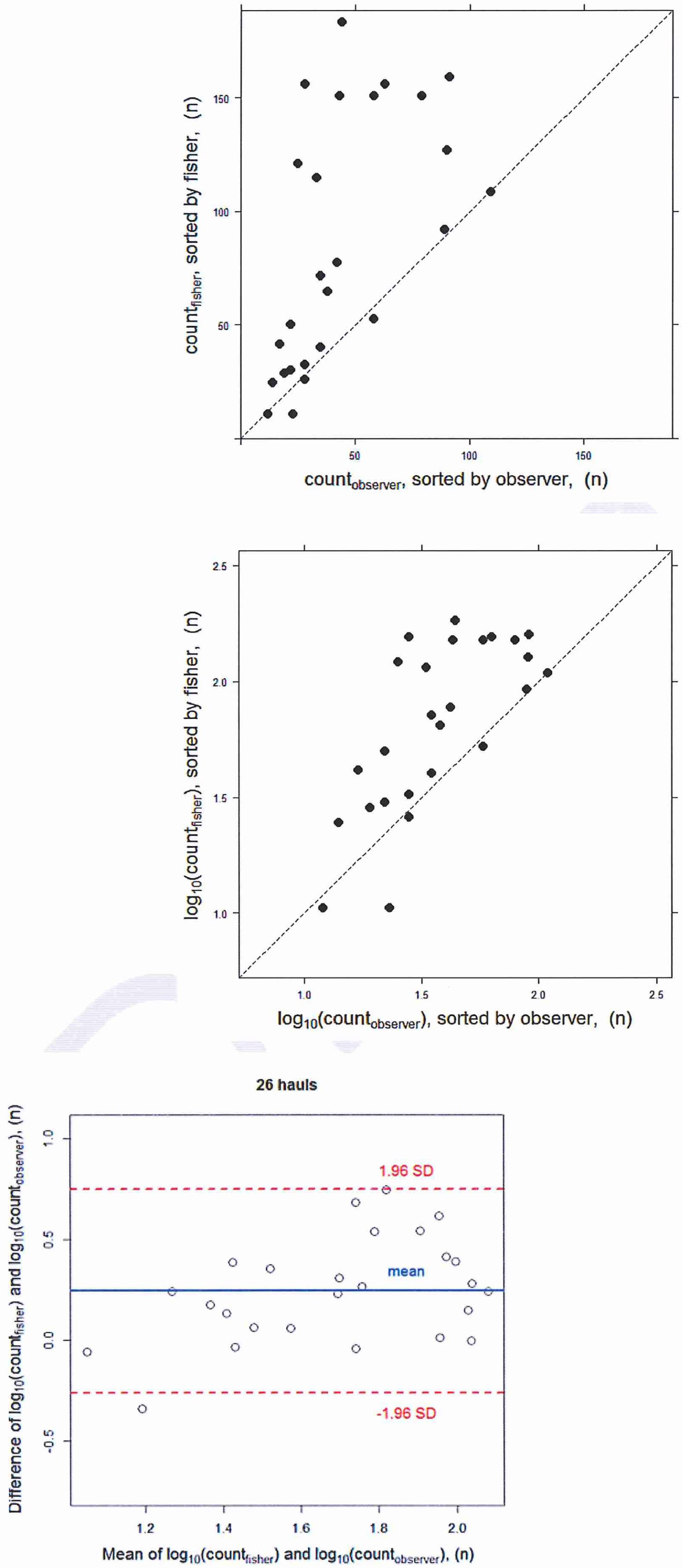
150
100
50
50
100
150
count_fisher, sorted by fisher, (n)
count_observer, sorted by observer, (n)
2.5
2.0
1.5
1.0
1.0
1.5
2.0
2.5
log10(count_fisher), sorted by fisher, (n)
log10(count_observer), sorted by observer, (n)
26 hauls
1.96 SD
mean
-1.96 SD
1.0
0.5
0.0
-0.5
1.2
1.4
1.6
1.8
2.0
Difference of log10(count_fisher) and log10(count_observer), (n)
Mean of log10(count_fisher) and log10(count_observer), (n)

Figure 2.

Separate display in front of camera

To compare the systematic differences, we conducted the paired t-test (equal variance) of the log-tranformed number between logbook records in numbers and video observations based on the separate display of undersized sole after the soring process. The result indicates no systematic differences (p-value = 0.54, mean of diff = -0.01). Additionally, the scatter plots show the points are consistently overplayed on the diagonal line, suggesting a high agreement between the two counts. The Pearson correlation coefficient between the two methods is high 0.98 (95%CI: 0.96-0.99), implying that the counts from the two methods are highly linearly correlated. Because XXXX, we believe that such result can be generalized to all vessel types.

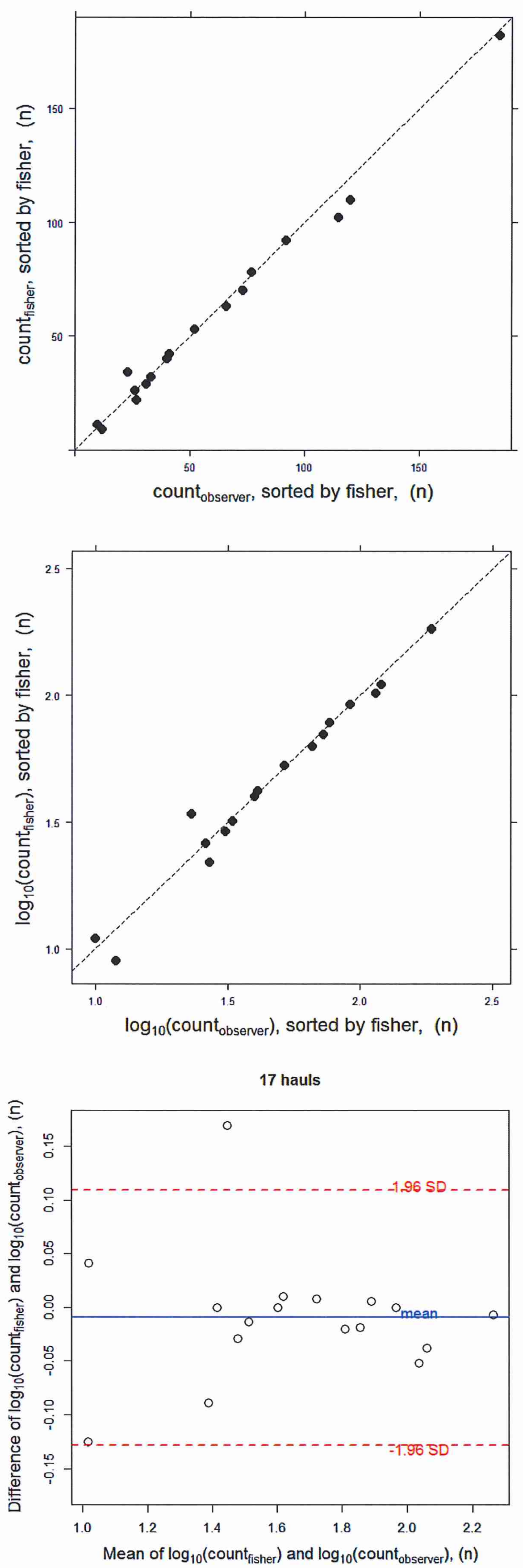
count_fisher, sorted by fisher, (n)
count_observer, sorted by fisher, (n)
50
100
150
log10(count_fisher), sorted by fisher, (n)
log10(count_observer), sorted by fisher, (n)
1.0
1.5
2.0
2.5
17 hauls
Difference of log10(count_fisher) and log10(count_observer), (n)
Mean of log10(count_fisher) and log10(count_observer), (n)
1.96 SD
mean
-1.96 SD
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
1.0
1.2
1.4
1.6
1.8
2.0
2.2

Figure 3.

(Preliminary) conclusions

Based on the preliminary results we conclude that video review, only based on the sorting process, significantly underestimates the number of undersized sole, compared to the logbook records. Using a method or protocol to allow better recording of individual fish, significantly improves the efficacy of video monitoring: the results suggest a high agreement between records in logbooks and video observation for undersized sole in numbers.

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Attachments:

- Publication in Marine Policy: changes in fishing behaviour of tow fleets under fully documentet catch quota management: Sam rules, different outcomes
- Publication in ICES Journal: contribution to the symposium: Fihery-dependent information