Monitoring of cod catches in Dutch otter trawls and seines

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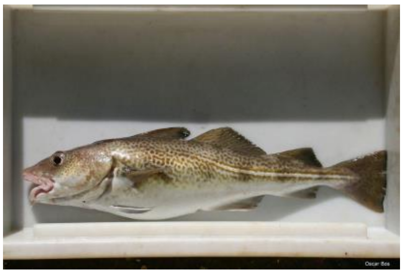

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Contents

Summary

This report presents the results of the Dutch Cod Monitoring Project (TRMON) in the bottom trawls and seines (TR) that was carried out in 2013. Due to the Dutch Cod Avoidance Plan (DCAP), the transition of effort between different fishing gears is restricted.

In 2011 this project was set up to improve the monitoring of cod catches, since other monitor programmes did not cover all relevant fishing gears or were not aimed at less frequently caught species. The TRMON consists of self-reporting fishermen and an extra set of observer trips. These data are combined with data of other sources, being the Dutch discard monitoring project carried out under the Data Collection Framework (DCF), the CCTV (camera) monitoring project and the EU-logbooks from the skippers, containing the landings.

Since the data is collected in different projects, variation is large. Therefore, an analysing method is chosen in which the landings are the most important information. Discard percentages of cod are calculated for each fleet segment, monitor program and quarter separately and applied to the landings. With this method, variation between the different monitor program results is corrected for.

Both the Landings per Unit Effort (LpUE) as the Catch per Unit Effort (CpUE) in 2013 are lower for all fleet segments compared with the LpUE and CpUE of the previous report (2011-2012). The decline in LpUE is (percentage wise) largest in the BT2 fleet. The conversion factor for the transition of days-at-sea (DAS) between the TR2/TR1C and BT2 amounts to 1:3.12. This is higher than the conversion factor of 2011-2012 (1:2.25). However, the percentage of the number of trips with cod catches lower than 5% is higher in 2013, with 94% and 96% in the TR2 and TR1C segment respectively (2011-2012: 87%(TR2) and 94%(TR1C)).

The large decline in LpUE in the BT2 fleet probably explains the higher conversion factor. All LpUE have declined in 2013. However, ICES calculated a small increase in stock size for cod. For this reason, it would be very interesting to investigate why the landings have decreased. Possible explanations include a shift in fishing location, a shift in gear employment and a shift in cod abundance per location. This could be monitored using VMS data and a more frequent and detailed update of knowledge of the gears employed in the different fleet segments.

Introduction

The monitoring program is part of the cod avoidance plan developed by the Dutch government together with the Dutch fishing sector. The aim of this monitoring program is to provide information on the Catch per Unit of Effort (CpUE) in the TR fleet. This is needed in order to calculate a conversion factor between the TR and BT (beam trawl)[1] gears. The transition of kW-days between gears is regulated by the cod recovery plan and depends on the CpUE ratio of cod between the respective gear groups.

In the Dutch cod avoidance plan, the Dutch government distinguishes between otter/pair trawlers that are directed to cod (TR1AB[2]) and those for which cod is by-catch (i.e. TR1C and TR2). The DAS transition only applies to fisheries with cod as by-catch (Table 1). The Netherlands use a conversion factor of 3:1 between the BT and the TR gears with cod as bycatch (TR1C and TR2).

Since 2011, cod catches in the TR fleet are monitored (TRMON), by making use of self-reporting. The first report was published in June 2013, covering the first monitoring period (week 46 in 2011 up to and including 2012) (Kraan et al. 2013). Current report is the second report covering the year 2013. Extra observer trips were chosen since the existing monitoring projects of IMARES did nog provide enough observations of some gear groups to reliably estimate cod CpUE's. Self-reporting was chosen in order to have a high coverage at a relatively low cost. The calculation of the CpUE has been done based on the results of the TRMON and other monitoring projects.

Table 1. *Overview of fleet segments; gear categories, gears and mesh sizes of relevant Dutch demersal fisheries.*

Gear category	Gear	Mesh size (range)	Comments
Otter/pair trawls and seines (OTB,OTT,PTB,SDN,SSC,SPR)	TR1AB	≥ 120 mm	Cod as target species
	TR1C	≥100mm - < 120mm	Cod as by-catch
	TR2	≥ 79 mm - < 100 mm	Cod as by-catch
Beam trawls (TBB)	BT2	≥ 79 - 120 mm	Cod as by-catch

[1] And other gears (gillnets, trammel nets and long lines) which are not relevant for this report.
[2] Some fishermen fishing with a TR gear, 120+ mesh size are targeting plaice with cod as a minor by-catch.

Assignment

The Ministry of Economic Affairs asked IMARES in 2013 to continue with monitoring cod catches (both landings and discards) in the Dutch TR fleet with the aim to:

i) estimate the CpUE (expressed in kilos of cod caught per days at sea (DAS) per TR fleet segment; and

ii) compare those with the CpUE in the BT fleet (based on monitoring of this fishery under the European DCF); and

iii) calculate the percentage of trips in the TR fleet (TR2, TR1C), with less than 5% cod catches in relation to the total catch (this is referred to as 'cod avoiding fishing trips' in the Dutch cod avoidance plan).

Material and methods

3.1 Calculate discard quantities for cod.

Cod discards were calculated with data from three different monitoring programmes: 'TRMON', 'DCF' and 'CCTV' (Table 2). In the sections below, these monitoring projects are briefly introduced. For each unique combination of fleet segment and monitoring project, the ratio between cod landings and discards was calculated per quarter.

MONITORING PROJECT	FLEET SEGMENTS					
	TR1AB	TR1C	TR2	BT2	Data collector	Source
TRMON (SS)	X	X	X		Crew-member	Logbook
TRMON (OBS)		X			Research staff	IMARES
DCF	X	X	X	X	Crew-member/ research staff	Samples
CCTV	X	X	X		Crew-member/ CCTV & research staff	Logbook/CCTV images

Table 2. List of monitoring projects and fleet segments for which either sampled or self-reported logbook data of cod catches were available. X indicates whether that fleet segment was covered in the monitoring project.

3.1.1 Cod monitoring project (TRMON, both SS and OBS)

In 2011, IMARES was requested by the Ministry of Economic Affairs to start a cod monitoring programme in TR gears. This resulted in the TRMON-project; a self-reporting project in which fishermen report their total catches of cod per haul (TRMON SS). The undersized fraction and the market categories are recorded separately. Also, haul specific information, like fishing position, gear employment and haul duration are registered. For the TR1C segment only, 6 extra observer trips have been conducted as well (TRMON OBS). During these trips, an observer measured all cod caught, to compare self-reporting data with observer data. For more information about the set-up of the TRMON-project, see Appendix A and Kraan et al. (2013).

3.1.2 DCF monitoring project (DCF)

In the European Union, the collection of discard data at-sea is enforced through the Data Collection Framework (DCF). In the Netherlands, IMARES coordinates a cooperative research with the commercial fisheries -the so-called self-sampling discards programme- in which a reference fleet is assigned to a sampling scheme (Uhlmann et al. 2013). Samples are taken from the discard fraction of the catch by fishermen (according to a sampling protocol) and brought to port. There, the samples are collected and further processed by IMARES. In 2013, DCF sampling covered BT2, TR1C, TR2 and TR1AB gears (in order of decreasing sampling effort; Table 3).

3.1.3 CCTV - monitoring project (CCTV)

The utility of CCTV cameras to fully documented catches of cod was tested on board of five vessels representing TR1AB, TR1C, and TR2 gear groups in a pilot study (Helmond et al. 2012). Skippers were asked to register and self-report kg catch weights of cod below and above MLS (similar to the self-reported data sheet in the TRMON project, see Figure 2 in appendix A). Cod catches were aggregated over fishing days and weeks, because this was the lowest, achievable level of aggregation. All participating vessels were equipped with an electronic monitoring system of hardware (CCTV cameras and sensors) and software components which logged all fishing operations during a trip. The data were downloaded from portable hard drives and processed at the research laboratory. An IMARES staff member screened the CCTV camera footage and noted the number of cod below and above marketable size. Based on length-weight relationships, numbers-at-length were converted into kg weights. These estimates were used to validate the self-reported cod catches. After screening all footage was destroyed. To make comparisons with discard/landings weights from the cod monitoring project, we used validated logbooks of cod landings and discards of vessels participating within the CCTV monitoring project.

3.2 Calculate CpUE

For all trips in the monitoring projects, the catches of cod (in kg: total, <MLS, and >MLS) were summed per sampled trip. For all trips with cod landings, a ratio was calculated between the total trip weight of cod discards and landings. From these trip-level ratios, an average (±SE) was calculated per quarter, fleet segment and monitoring project for 2013. Logbook reported landings per quarter were multiplied with the calculated average discard ratios taking the variation (based on their mean and standard error) into account, resulting in estimates of discards and -summed with landings- catches per quarter. These catches per quarter were summed, resulting in aggregated catches over the whole year. This was divided by the total fishing effort, resulting in CpUE estimates. In line with ICES working group procedures, fishing effort was expressed as the days spent at sea (DAS) times the kW power capacity of the vessel. The CpUE estimates per respective fleet segment allowed for the calculation of an effort ratio between BT2 and TR gears. By repeating this calculation a 1000 times a standard deviation for the ratio estimate was generated.

This approach, of applying cod discard percentages, derived from all monitoring projects separately, to LpUEs to estimate CpUEs, gives greater importance to the bulk of the data (the landings) which also is the most accurate information available. Via this approach variability in CpUE estimates is relatively small, even if there is some variability in the estimated discard: landings ratios. However, to justify this approach, we needed to investigate whether there is a linear (positive) relationship between cod landings and discards. This would demonstrate that with increasing amounts of landings, the amount of discards also proportionally increases. In figure 1, the linear relationships between landings and discards are shown for all the fleet segments.

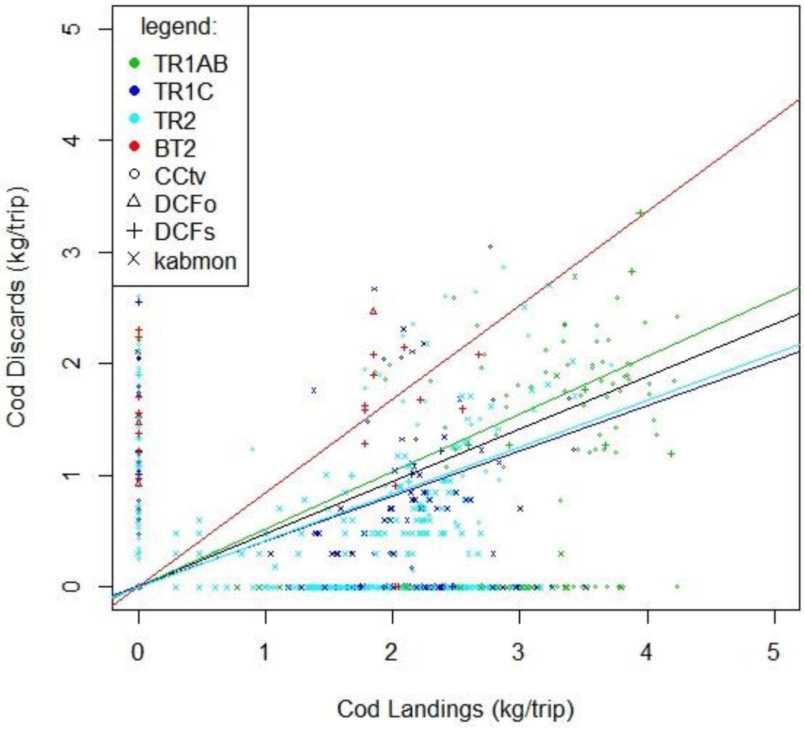

Figure 1. *Relationships (linear regression) between log-transformed kg weights of cod landings versus discards for sampled hauls during either self-reported, observer- or self-sampled trips of the cod and DCF monitoring projects in 2013. Only trips with both landings and discards are taken into account. Green, TR1AB; Dark blue, TR1C; light blue, TR2; and Red, BT2 (data of TRMON (OBS) not included.)*

3.3 Cod-avoidance fishing trips.

Using EU-logbook data, total landings and the total quantity of cod landings per fishing trip were calculated per fleet segment. Then the cod discards per fishing trip were estimated, using the fleet segment specific discard ratios calculated as described in 3.2. The discards of the other species in the landings are calculated using discard percentages based on estimates from DCF-data per fleet segment. Total catch per fishing trip is calculated as the sum of total discards and total landings. The percentage of cod in the total catch was calculated per fleet segment and the fraction of trips with <5% cod in their total catch was determined.

Results

Over the sampling period (2013) 411, 643, 2116 and 6747 fishing trips in the TR1AB, TR1C, TR2 and BT2 segments respectively were officially registered in the national database. For about 18% of the trips with TR gears information on cod catches was available and submitted/self-reported by the fishermen (TRMON) (see Table 3). If we calculate the coverage excluding the CCTV vessels (which were not obliged to participate), the coverage is 19%. The sampling coverage was thus well below the 100%, as agreed in the Cod Avoidance Plan (see also Kraan et al. 2013). For all, but the BT2 segment, comparable data are available from at least three different sampling projects (Table 3).

Fleet segment	Project	Source	Vessels	Trips
TR1AB	TRMON	Logbook	8	34
	DCF	Self-sampled	2	7
	CCTV	Logbook	9	105
TR1C	TRMON	Logbook	11	103
	TRMON	Observer	6	6
	DCF	Self-sampled	3	14
	CCTV	Logbook	7	73
TR2	TRMON	Logbook	29	422
	DCF	Self-sampled	4	9
	CCTV	Logbook	8	204
BT2	DCF	Self-sampled	12	83
	DCF	Observer	6	6

Table 3. *Number of sampled vessels and trips in each fleet segment and monitoring project. The source of reporting refers to whether data were either self-reported or sample-based for the period 2013 (database query April 2014).*

4.1 Proportion of discarded cod per fleet segment

Among the sampled trips, the amounts of discarded cod are typically fractions of the amounts of cod landings, on average 20%, but ranging between 0 and 195% in some quarters and sampling projects (Table 4). Discard percentages were lowest in the cod-directed fishery (TR1AB) and the highest in the TR1C segment during CCTV monitoring (Table 4).

For the TR1C segment, data were available within the TRMON project from self-reporting fishermen and an extra set of observer trips, as this metier was not well covered in the DCF (see Kraan et al. 2013). TR1C is a seasonal fishery, peaking in summertime (see Table 5). Therefore observer trips were planned in quarter 2 and 3, while for quarters 1 and 4 the assumption was made that similar discard quantities are caught as in summer. In the TR1AB and TR2 segments, the DCF data did not cover the fleet effort well enough and this monitoring program was therefore not analysed for these segments.

4.2 Cod landings and effort

In total, 1274 tonnes of cod were landed by the Dutch fleet categories TR1AB, TR1C, TR2 and BT2 in 2013 (Table 5). As expected, the cod-targeting fishery TR1AB landed much more cod than TR2. Landings seemed to increase in quarter 1 (BT2) and quarter 3 (TR1AB).

Fishing effort and LpUE by fleet segment are shown in Table 5. Effort by TR1 is generally concentrated during quarters 3 and 4. LpUE of cod was highest in TR1AB and lowest in BT2.

Fleet segment	Sampling project	Quarter	Number of trips	Mean percentage of Cod discards	Standard deviation
TR1AB	CCTV	1	10	0.0%	0.1%
		2	15	2.5%	6.3%
		3	58	8.4%	24.3%
		4	14	13.2%	30.8%
	TRMON (SS)	1	3	0.0%	0.0%
		2	16	0.0%	0.0%
		3	9	2.9%	7.4%
		4	3	0.0%	0.0%
	DCF	1	0	NA	NA
		2	0	NA	NA
		3	4	9.0%	11.7%
		4	3	2.4%	2.1%
TR1C	CCTV	1	0	NA	NA
		2	1	195.2%	NA
		3	17	11.5%	32.3%
		4	9	13.5%	31.5%
	TRMON (SS)	1	1	0.0%	NA
		2	23	56.9%	144.5%
		3	45	3.3%	7.7%
		4	17	2.1%	3.7%
	TRMON (OBS)	1	0	NA	NA
		2	4	19.8%	21.0%
		3	2	2.0%	2.2%
		4	0	NA	NA
	DCF	1	0	NA	NA
		2	1	0.0%	NA
		3	5	2.6%	3.6%
		4	0	NA	NA
TR2	CCTV	1	24	29.7%	48.7%
		2	23	19.7%	47.1%
		3	2	116.6%	162.4%
		4	6	0.3%	0.7%
	TRMON (SS)	1	41	0.3%	0.7%
		2	75	10.5%	76.0%
		3	147	6.6%	24.4%
		4	52	16.8%	42.2%
	DCF	1	4	6.9%	8.5%
		2	1	0.0%	NA
		3	0	NA	NA
		4	0	NA	NA
BT2	DCF	1	12	5.3%	10.5%
		2	2	88.0%	115.0%
		3	1	0.0%	NA
		4	7	55.6%	47.4%

Table 4. *Mean discard percentages by fleet segment, monitoring project and quarter for 2013. Sampling projects included CCTV: electronic video monitoring, DCF: observer or self-sampled trips of the DCF, TRMON: TR monitoring with either observers (OBS) or self-reporting (SS), NA: not applicable.*

	Landings (t)					Total effort				LpUE			
Q	TR1 AB	TR1 C	TR2	BT2	Total	TR1 AB	TR1 C	TR2	BT2	TR1 AB	TR1 C	TR2	BT2
1	45	3	46	288	382	56	27	515	5597	0.80	0.11	0.09	0.05
2	26	19	39	30	114	62	310	461	4897	0.41	0.06	0.08	0.01
3	479	21	45	27	572	234	344	548	4770	2.05	0.06	0.08	0.01
4	92	12	12	90	206	57	140	423	4887	1.62	0.09	0.03	0.02
Total	**642**	**55**	**142**	**435**	**1274**	**409**	**821**	**1947**	**20151**	**1.57**	**0.07**	**0.07**	**0.02**

Table 5. *Total cod landings (t), effort (1000 KW days) and landings per unit of effort (LpUE) by fleet segment (TR1AB, TR1C, TR2, and BT2) in the Dutch fleet. Source: EU logbooks.*

4.3 Catch per Unit Effort by fleet segment

Estimates of cod CpUE were derived by adding a fraction of discards to the known amount of landings (see section 3.2). This approach can be justified when a linear relationship between the amount of discards and landings has been established (figure 1). Cod landings and fishing effort for the respective fleet categories and quarters were selected from the EU-logbook database (table 5). Based on the estimated quarterly discards: landings ratios (table 4), corresponding cod catches and CpUE could be estimated (table 6). Only monitoring programmes of which at least 3 quarters were sampled per fleet were used. However, exceptions were made for the DCF and the TRMON (OBS) programmes in the TR1C fleet. This fleet operates mostly in spring and summer, while during fall and winter this fishery is much lower (table 5). For both the TR1AB and the TR2 fleet, the ratios of the DCF programme were not used in calculations of CpUE.

The estimations of CpUEs were done using the results of estimated discards: landings ratio for the monitoring projects separately. The range of estimated values between monitoring projects was too large to use one overall average discards: landings ratio per fleet segment. Therefore, an iterative procedure (n=1000) was used for calculation of quarterly catches from quarterly landings and quarterly mean discards: landing ratios with their standard errors.

The discards: landing ratio in a single iteration was drawn randomly from a normal distribution using the observed mean and standard error as input. By summing the quarterly catches, an overall CpUE for the different fleet segments was calculated by dividing with the summed effort. Finally, an estimation of the CpUE ratio (table 6) could be calculated including its variation (due to the different monitoring projects) whereby also the seasonal variation has been taken into account. For each of the TR fleet segments, an average annual CpUE of cod was estimated based on, at the most, four different sources of data. This resulted in an estimate by fleet segment and project (Table 6).

Our results (ratio column of table 6) show that the DAS ratio (CpUE ratios) between TR1C and TR2 on the one hand and BT2 on the other hand, fluctuated around 3, with an average value of 3.12 (Table 6). The DAS ratio between TR1AB and BT2 was considerably higher, with an average value of 62.5 (Table 6).

Fleet segment	Monitoring project	Catch (t)	Effort (kW DAS)	CPUE (kg/kW DAS)	DAS ratio (to BT2)	StDEV Ratio
TR1AB	TRMON	645	409	1.575	62.09	0.462
	CCTV	654	409	1.597	62.93	0.495
TR1C	TRMON (SS)	65	821	0.079	3.13	0.096
	TRMON (OBS)	57	821	0.070	2.80	0.036
	CCTV	63	821	0.077	3.04	0.067
	DCF	47	821	0.057	2.28	0.037
TR2	TRMON	145	1946	0.075	2.94	0.023
	CCTV	223	1946	0.115	4.52	0.170
BT2	DCF	511	20151	0.025	1	0

Table 6. *Estimated catch (t), effort, CPUE, and average ratios between CPUE of TR gears and beam-trawl (± standard deviation of the ratio: StDEV).*

4.4 5% rule

Table 7 shows the fraction of trips in which the share of cod in the landings in regard of the total landings was less than 5%. On average 93% of the TR1C landings and 90% of the TR2 landings contain less than 5% cod. The species composition of landings is presented in table 8. Dominant species in the landings are plaice for TR1C and plaice, variable species, whiting and nephrops for TR2. On average 1.9% (TR1C) or 1.3% (TR2) of the landings is cod.

Discard percentages of cod used to estimate cod catches per trip are the averages per quarter for the various fleet segments. Discard percentages of other species in the landings are calculated from the DCF program. In case no estimation of discard fraction for a particular species is available, a discard percentage of 100% was used; being the weighted average of landings with known discards fractions. Yearly percentages are the average of the calculated quarterly percentages. The fraction of trips that meet the 5% rule, and caught less than 5% cod during the trip, is presented in table 9. On average 96% of the TR1C trips and 94.25% of the TR2 trips had small cod catches (Table 9).

Quarter	Fleet segment	N	Fraction less than 5 per cent cod in the landings
1	TR1C	42	0.95
2	TR1C	127	0.92
3	TR1C	122	0.94
4	TR1C	82	0.90
Average	**TR1C**	**373**	**0.93**
1	TR2	371	0.87
2	TR2	356	0.89
3	TR2	342	0.86
4	TR2	322	0.96
Average	**TR2**	**1391**	**0.90**

Table 7. *Fraction of TR1C and TR2 trips with less than 5% cod in the landings*

SPECIES	TR1C	TR2
Plaice	19	66.8
Nephrops	11.5	0.1
Cod	1.9	1.3
Turbot	1.2	1.2
Dab	4.7	8.8
Mackerel	8.9	3.7
Whiting	12.4	1.0
Horse mackerel	7	4.0
Grey Gurnard	1	0.8
Brill	0.3	0.1
Tub Gurnard	10.9	6.5
Sole	0.4	0.0
Lemon sole	0.7	2.7
Edible crab	0.3	0.2
Bib	3.8	0.1
Flounder	0.2	0.1
Haddock	0.2	0.2
Other	15.6	2.4

Table 8. *Species composition (% of total) of TR1C and TR2 landings*

Quarter	Fleet segment	N	Fraction less than 5 per cent cod in the catch
1	TR1C	42	0.98
2	TR1C	127	0.93
3	TR1C	122	0.99
4	TR1C	82	0.94
Average	**TR1C**	**373**	**0.96**
1	TR2	371	0.94
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Average	**TR2**	**1391**	**0.94**

Table 9. *Fraction of TR1C and TR2 trips with less than 5% cod in the catch*

Discussion

5.1 LpUE effects on DAS-transfer conversion factor

5.1.1 Changes in LpUE

The applied method to calculate CpUEs for the different monitoring projects is mainly based on the landings data, since this data is the most accurate and the largest share of the total catch. Small changes in the LpUE of the different fleet segments with respect to last year therefore can have a large effect on the conversion factor of transfer in DAS. The average LpUE of the BT2 fleet in 2011 and 2012 has halved in 2013, from 0.04 to 0.02 (Kraan et al. 2013). The LpUEs of all other fleets have declined as well, but not with similar percentages. In 2011 and 2012, the DAS-transfer conversion factor, based on landings only, was well below 3 (2.25). For 2013, however, this factor has increased to 3.12.

5.1.2 Possible explanations of observed LpUE changes

Several possible explanations can be given for the observed decline in LpUE. First of all, a widely used 'rule' is that, if LpUE declines while efficiency of the effort remains the same, the stock probably has declined. Since the LpUE of all four different fleet segments have decreased, this explanation sounds logical. However, ICES' assessment of cod population of 2013 showed a small increase in cod abundance (ICES 2013). Therefore, this observed decrease in LpUE is unlikely to be caused by a decline in stock. A second possible explanation of the decreased LpUE is that quota were limiting, and that fishermen where obligated to discard well-sized cod. However, the Total Allowable Catch (TAC) for cod in the North Sea was equal for 2013 and 2012, and both TACs were not completely used[3]. Therefore, this observed decrease in LpUE is unlikely to be caused by limiting quotas.

The observed decline in LpUE in the BT-fleet might be caused by a shift in gear (pulse) or change in gear set-up (large square mesh panels) and with that, a shift in fishing strategy and efficiency. Otherwise, it could be the result of other cod-limiting measures such as move on regulations or RTC's. It would be very interesting to see whether such transitions have taken place in 2013 and if and how this affected fishing strategy. Pulse trawlers, for instance, are active at different fishing locations than normal beam trawlers (personal communication). This will probably affect the efficiency of several species, since most species –including cod- prefer specific bottom types, depths or temperatures (Wieland et al. 2009; Sell and Kröncke, 2013; Engelhard et al. 2014).

In future, it would be very interesting to localise fleet location (for each fleet segment separately) and observe possible fleet location shifts. In appendix C (figure 3), fishing positions are plotted for both the TRMON and the DCF monitor programmes, for the years 2012 and 2013 separately. The resolution is low in these graphs, however, a shift in BT2 fishing positions (within the DCF program) can already be observed between 2012 and 2013. The fishing locations of the TR gears, observed in the TRMON project also differ between years. No spatial analysis is performed on these data yet. To get such an analysis, a more accurate visualisation of the fishing locations of all (Dutch) vessels using VMS-data would be preferable. Likewise, gear employment of the beam trawling fleet should be visualized and compared with the reported landings over time.

5.2 Changes in discard percentages with respect to 2011-2012

Overall applied discard ratios per fleet segment can be calculated by dividing the CpUE by the LpUE. The TR2 fleet has the largest applied discard ratio (1.36). The other ratios are 1.25 (BT2), 1.01 (TR1C) and 1.01 (TR1AB). Compared with the applied discard ratios in 2011 - 2012, the ratios are in equal ranges,

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[3] http://ec.europa.eu/fisheries/cfp/fishing_rules/tacs/index_nl.htm

except for the BT2 ratio, which decreased from 1.6 to 1.25 (Kraan et al. 2013). That is a decrease of 22%. Most likely, this change in discard ratio is correlated with the decline in LpUE. However it could be an extreme effect of patchy monitoring, as the DCF is less 'equipped' for cod sampling (see Kraan et al. 2013). For some reason, the BT2 fleet catches less cod than in the previous years, both discards and landings.

5.3 5% rule

The observed decline in LpUE can be seen in the percentage of trips with low cod catches and landings as well. In 2013, the TR2 segment had in 90% of their trips less than 5% cod in their landings and in 94% of their trips less than 5% cod in their catches. For the TR1C segment, these percentages were even higher, with 93% of their trips with less than 5% cod in their landings and 96% of their trips with less than 5% cod in their catches. In 2011-2012, these percentages were lower, with respectively, on average 80% and 90% of the trips in the TR2 and TR1C segments with less than 5% cod in their landings and 87% and 94% in the catches. Especially the TR2 fleet is catching less cod with respect to 2011-2012. The reason for this phenomenon is unclear. Perhaps a change in fishing behaviour could explain this decrease in cod catches, but a shift in cod distribution might explain the decrease as well.

5.4 Recommendations

As the methods used in the cod monitoring project have not yet been revised, many of the points made in the evaluation of the project and recommendations (Kraan 2013: paragraphs 5.2 and 5.3) are still applicable. We therefore reiterate our recommendation to revise the set-up of this cod monitoring project. This report shows that discards are a minor fraction of cod catches. Moreover, the discard fractions only have a small effect on the CpUE ratios. If a LpUE ratio would be used the outcome would be in the same range (3.75) as with the CpUE ratio now calculated by the monitoring programmes (3.12). This underlines the argument made in the previous report that the need for close monitoring of cod catches is not needed from a scientific point of view. However a better understanding of the landings (per unit effort) is desirable. LpUE has shown to differ between years, however, the reason for these differences is unknown. Time-series of landings, in combination with time-series of fishing locations, gear employment, cod abundance, and interviews with fishermen will probably help to explain why differences are observed between years and fleets, and can therefore better be translated to cod-protecting-management.

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

Report number: C105/14
Project Number: 4308101082

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

Approved: Ruud Jongbloed
Researcher

Signature:

Date: 8 July 2014

Approved: Nathalie Steins
Head of department Fisheries

Signature:

Date: 8 July 2014

Appendix A. History of the cod monitoring project (TRMON)

The 'cod monitoring project' (TRMON) was set up in 2011 by IMARES after a request by the Ministry of Economic Affairs to start a project to monitor cod catches (both landings and discards) in the Dutch bottom trawl and seines (TR) fleet. While reported landings and effort are relatively accurate and precise, estimates of discards may be inaccurate, biased and imprecise, especially if they are based on a limited sampling project and very low numbers of cod in the catch. This is the case for TR trips. Discard sampling by observers is expensive; therefore the number of sampling trips is restricted and mainly focused to beam-trawl fisheries which constitute the major demersal fishery by the Netherlands.

The TRMON project was set up by IMARES to improve the precision of discard estimates of the TR fleet, and also to expand the monitoring to previously not so well covered TR fleet segments. As a first step, it was necessary to determine the minimum number of trips that were needed to be monitored to obtain sufficiently reliable estimates of cod discards. This depends on variation in cod catches, in particular of discarded fractions (presence/absence of undersized cod) between trips. If discarded amounts differ greatly between trips, more trips need to be sampled to improve the precision of discard estimates.

Historically, a limited number of TR trips had been carried out resulting in limited information on cod discards in TR gears. Six trips were monitored between 2007 and 2008 on board of otter trawlers targeting *Nephrops* (van Helmond and van Overzee 2009). Extrapolating from the variation that was recorded in the amount of cod discards (weight) in these trips, at least 50 trips per year per TR segment must be monitored to reduce the coefficient of variation of the discard estimate to <20% (Figure 1) (Borges et al. 2005).

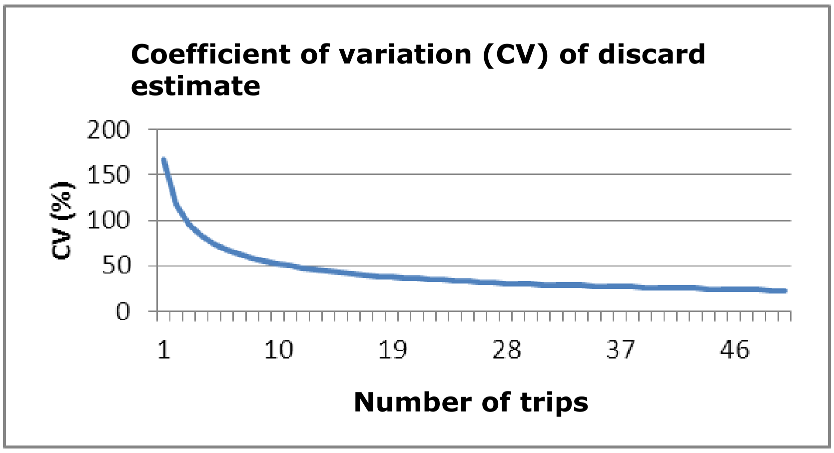

Figure 1. *Coefficient of variation (CV; CV=SE/mean*100%; where SE=SD/$\sqrt{n}$) of estimated kg discard weights of cod in relation to the number of sampled trips. Extrapolated from data of a monitoring project in the Dutch otter-trawl fishery for Nephrops (2007-08).*

To monitor at least 50 trips with TR gears, it was suggested to set up a self-reporting 'cod monitoring project' (TRMON), where fishermen with TR gears monitor their catches (of both quantities of cod landings and discards) in each haul they make. The Ministry and fishing sector agreed under the condition that all vessels using the TR1 or TR2 gear[4] participate in this project.

The project started in July 2011 (week 28). All fishermen active in the TR-segments were provided with data forms for cod catch registration and via the Dutch fishermen's organisations ("VisNed" and "de Nederlandse Vissersbond") they were instructed how to sample and register the data. Ideally, after every trip these forms were sent to IMARES where their data were processed further.

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[4] Vessels participating in fully-documented fishery trials (i.e. 'Close-circuit-TV/CCTV electronic monitoring') were exempted.

After a few weeks, it turned out that the initial catch registration form demanded too much time from the fishermen to fill out whilst being busy sorting the catch. Therefore, the data form was adjusted and used from week 46 of 2011 onwards.

The revised and simplified data form allowed for registering cod catches in kg per haul; split up by marketable (>35cm) landing- and undersized (<35cm) discard categories. In addition, kg weights of cod landings per trip are registered per market category length classes (1-5). Also 'further info' such as the engine power and mesh size must be registered. Figure 2 shows the data forms as provided to the fishermen.

Figure 2A)

CATCH IN KILO'S PER HAUL

haul	date	position setting net lat	long	duration haul	total cod catch (kg)	marketable cod (kg) (>35cm)	undersized cod (kg) (<35cm)
1							
2							
3							

Figure 2B)

COD LANDINGS PER TRIP

cod landings per market category (per trip) in kg					
1	2	3	4	5	
				sub I	sub II
(>88cm)	(72-88cm)	(55-72cm)	(46-55cm)	(40-46cm)	(35-40cm)

FURTHER INFO

Vessel nr.	
Vessel (code)	
Engine capacity (HP)	
Type of gear	
Mesh size	
Main retained species	

Figure 2. *Revised and final data form used by the fishermen from week 46 2011 onwards (translated from Dutch into English for this report). Part A): weights of total cod catches per haul (in kg), and the marketable (>MLS) and unmarketable fractions (<MLS). Part B): additional information of cod landings by market category per trip (in kg) and general information about the vessel and gear.*

Appendix B. Abbreviations

BT	Beam trawl
BT2	Beam trawl (mesh 80-99)
CCTV	Close-circuit-TV/CCTV electronic monitoring
CPUE	Catch per Unit Effort
DAS	Days at sea
DCF	Data Collection Framework
EU	European Union
ICES	International Council for the Exploitation of the Seas
IMARES	Institute for Marine Resources & Ecosystem Studies
Kg/KWday	Kilogram per kilowatt day
LpUE	Landings per Unit Effort
MLS	Minimum landing sizes
Q	Quarter
SE	Standard Error
StDEV	Standard Deviation
t	tonnes
TAC	Total Allowable Catch
TR	Bottom trawls, seines (such as twinrig, flyshooter)
TR1AB	Bottom trawls, seines mesh 120+mm
TR1C	Bottom trawls, seines mesh 100-119mm
TR2	Bottom trawls, seines mesh 80-99mm
TRMON	Monitoring of the TR gears via self-sampling / reporting of fishermen

Appendix C. Fishing locations

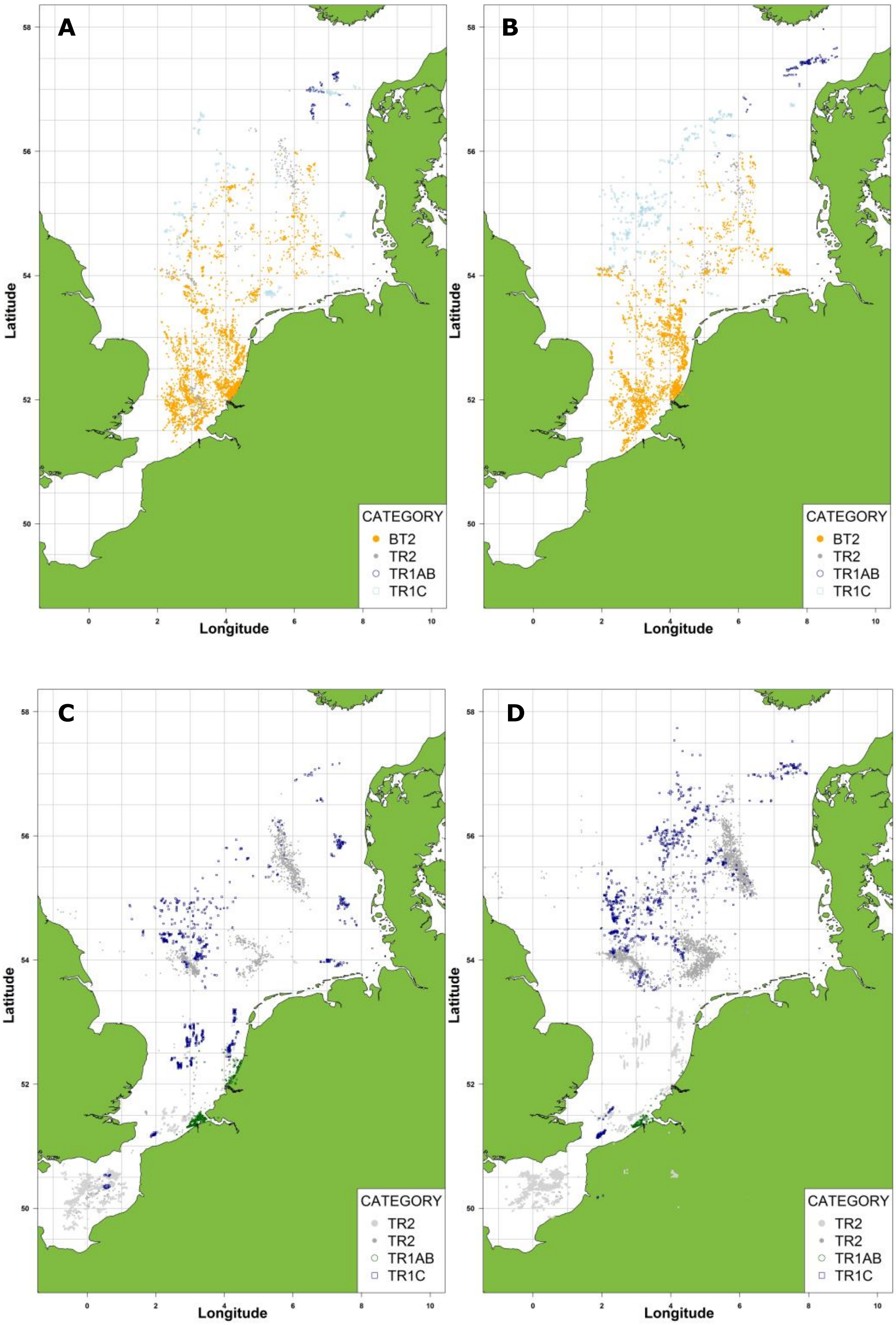

Figure 3. *Fishing positions of the different fleet segments in the DCF self-sampling program in 2012 (A) and 2013 (B) and the TRMON project in 2012 (C) and 2013 (D). In the TRMON fishing locations (C and D) are English Channel and North Sea trips of the TR2 vessels shown separately.*