Study of the effect of a By-catch Reduction Panel in a twin-trawl on reducing plaice discards

B. van Marlen, A.T.M. van Helmond, T.L. Pasterkamp and R. Bol

Report C106/08

- Wageningen **IMARES** conducts research providing knowledge necessary for the protection, harvest and usage of marine and costal areas.
- Wageningen **IMARES** is a knowledge and research partner for governmental authorities, private industry and social organisations for which marine habitat and resources are of interest.
- Wageningen **IMARES** provides strategic and applied ecological investigation related to ecological and economic developments.

Contents

Summary

Comparative fishing trials were conducted in November 2008 on the euro-cutter MFV TH-7 "Adriana Maria" on fishing grounds in the North Sea to investigate the effect of By-catch Reduction Panels inserted in a twin-trawl. In a total of 17 experimental hauls two nets were fished simultaneously, a conventional net on the starboard side and a net with a By-catch Reduction Panel inserted in the top sheet on the port side. The codend meshsize used was 80 mm. The main target species is plaice (*Pleuronectes platessa* L.). The By-catch Reduction Panel (BRP) tested was a square mesh panel with: 25 bars across and 22 bars deep of mesh size 150 mm, euroline™ single braid of 5 mm thickness. The panel was built in surrounding 80 mm netting and joined to 38 meshes in width and 19 meshes in depth in the port net of the twin-trawl, 12 meshes deep in front of the joining round of the codend. The panel reduced the by-catch of juvenile plaice by some 20% compared to the conventional net, but there may be a loss of marketable plaice. However, commercial losses were not confirmed by the skipper when regarding earnings over a longer period. When plaice discards are expressed as a fraction of total catch the differences were not found to be significant.

Samenvatting

In november 2008 werden vergelijkende visserijproeven gedaan op de eurokotter TH-7 "Adriana Maria". De visgronden bevonden zich in de Noordzee en het doel van de proeven was om na te gaan wat het effect is van het gebruik van zgn. Bijvangst Reductie Panelen in een 'twin-trawl'. Er werden in totaal 17 experimentele trekken gedaan met het stuurboord net van beide netten uitgevoerd als controle net, terwijl het bakboord net aan de bovenzijde was voorzien van het paneel. De maaswijdte van de kuilen was 80 mm. De doelsoort van deze visserij is voornamelijk schol (*Pleuronectes platessa* L.). Dit vierkante mazenpaneel telde 25 benen dwars bij 22 benen in diepte met 150 mm volle maaswijdte, materiaal euroline™ enkel gebreid garen van 5 mm dikte. Het was geplaatst op 12 mazen voor de kuilaanslag. Het paneel zorgde voor een vermindering in de bijvangst van onder-maatse schol met 20% in vergelijking met de conventionele uitvoering. Een klein verlies van marktwaardige schol kan echter ook optreden, hoewel de schipper dit aan de hand van zijn ervaringen in de praktijk vond meevallen. Als de scholdiscards worden uitgedrukt als fractie van de totale scholvangst zijn de verschillen statistisch niet significant.

1 Introduction

1.1 Problem description

Beam trawling is criticized on adverse ecosystem effects in recent years, e.g. on the high level of by-catch and discards, impact to bottom dwelling marine biota (Bergman and Santbrink, 1994; ICES, 2001; 2002; Jennings and Kaiser, 1998; Lindeboom and De Groot, 1998; Piet et al., 2000, Van Marlen, 2000), and this fishing method is becoming economically unviable due to the sharp increase in fuel oil prices, from 0.20 €/litre to approximately 0.70 €/litre in 2008 (Figure 1). Although there has been a drop in price recently, the prices are expected to increase again in the long term. Today a common opinion is that beam trawling will not be economically sustainable in the present form (Anon., 2006). At present the reduction of discards is placed high on the agenda in the EU (Anon., 2007). The fishing industry became aware of this criticism and is seeking ways to make fishing practice sustainable and acceptable. Fishermen have started to search for alternative ways of catching fish, among which using a 'twin-rig', a fishing gear composing of two trawls fished side-by-side, usually connected to two outer warps and a third wire to a clump weight in the centre.
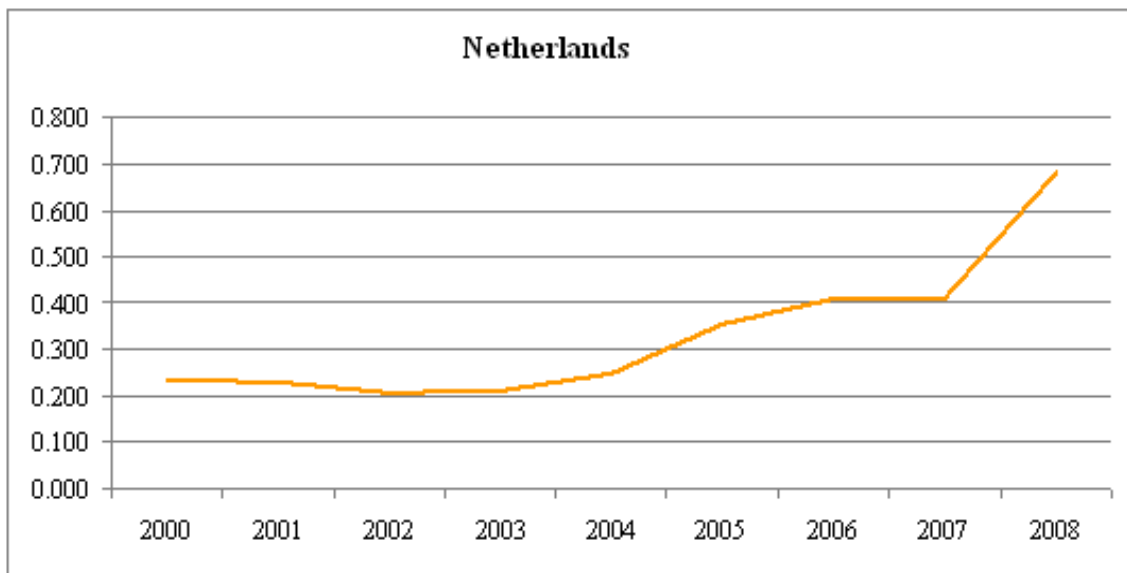
Figure 1: Development of fuel prices in the Dutch fishery in €/ltr , 2000-2008 (first 6 months)

In The Netherlands a Task Force on Sustainable North Sea Fisheries was established in 2006 which articulated the following points of action (Anon., 2006):

- "To Carry out 'pilot' projects for the mid-term to reduce discards in the traditional beam trawl fisheries and increase the chances of survival for fish being discarded."
- "To carry out research in close cooperation with the fishing industry on Technical Measures aimed at developing practical and effective technology which contributes to reducing discards, lower sea bed impact, higher product quality, in particular technical modifications in fishing gears to reduce by-catches."

Meanwhile the skipper and crew of MFV TH-7 "Adriana Maria" started to experiment with By-catch Reduction Panels (BRPs) in twin-trawls. A targeted project was set up on this topic to investigate the by-catch reduction potential of this technique. The study was carried out for the Dutch Fish Product Board (Productschap Vis) in

cooperation with the skipper and crew of the commercial vessel to develop such gear modifications. This report gives the results of this study, focusing on the main target species plaice.

2   Materials and Methods

2.1   Sea trips and vessel

The sea trials took place in week 45 of 2008 (03/11/2008-07/11/2008). Comparative fishing experiments were carried out onboard MFV TH-7 "Adriana Maria", a 300 hp vessel of type euro-cutter (Figure 2, Table 2-1) with a research team consisting of two researchers from IMARES. The twin-trawl consists of two nets that are fished simultaneously with the starboard side as the standard, conventional or control net, and the port side as the modified or test net in which the panel was inserted. The haul duration varied between 180 minutes to 240 minutes in order to enable a suitable number per configuration tested. The towing speed was approximately 3.0 kts, as is normal in commercial fishing with twin-trawls.

Figure 2: MFV TH-7 "Adriana Maria"

Table 2-1: Main particulars of MFV TH-7 "Adriana Maria"

Item	Value
Year built	2003
Length over all (m)	23.97
Breadth (moulded, m)	6.85
Depth (m)	n/a
Mean draft (m)	3.65
Main engine power (kW; hp)	221; 300
Main target species	Plaice, turbot, dab, etc.

2.2 Gears

2.2.1 General

The gear used was a twin-rig with two nets fished in a three warp arrangement. Both the control and the test net have a headline length of 34.8 m, a footrope length of 40.5 m, and were fitted with an 80 mm mesh cod-end. Particulars of the fishing gear are given in Table 2-2, and a net drawing in Figure 6.

Table 2-2: Main particulars of the fishing gears used

Item	Value
Gear code (e.g. TBB, OTB, OTM, …)	OTT
Type description	Twin-trawl
Otter boards (type, size, and weight)	Thyboron, 92", type 2, 700 kg
Sweeps	150 m, 14 mm thickness, 50 mm rubber discs
Clump weight (kg)	700 kg roller clump
Main gear dimensions (circumference, beam width, (m))	n/a
Headline length (m)	34.8
Footrope length (m)	40.50
Cod end mesh size (mm)	80
Comments	None

2.2.2 Details of the by-catch reduction devices used

The By-catch Reduction Panel (BRP) tested was a square mesh panel with: 25 bars across and 22 bars deep of mesh size 150 mm, euroline™ single braid of 5 mm thickness. The panel was built in surrounding 80 mm netting and joined to 38 meshes in width and 19 meshes in depth in the port net of the twin-trawl, 12 meshes deep in front of the joining round of the codend (Figure 3).

2.3 Sampling method

The catches of both port and starboard sides were collected separately in the fish bins on the upper deck (Figure 4). These catches consisted mainly of plaice with minor quantities of benthos and other fish, which were not investigated. All marketable plaice were collected from the total catch and their length measured. A sample of one basket of discards was taken from each catch per side. Undersized plaice were taken from these samples and measured. The weight of these samples was also measured.
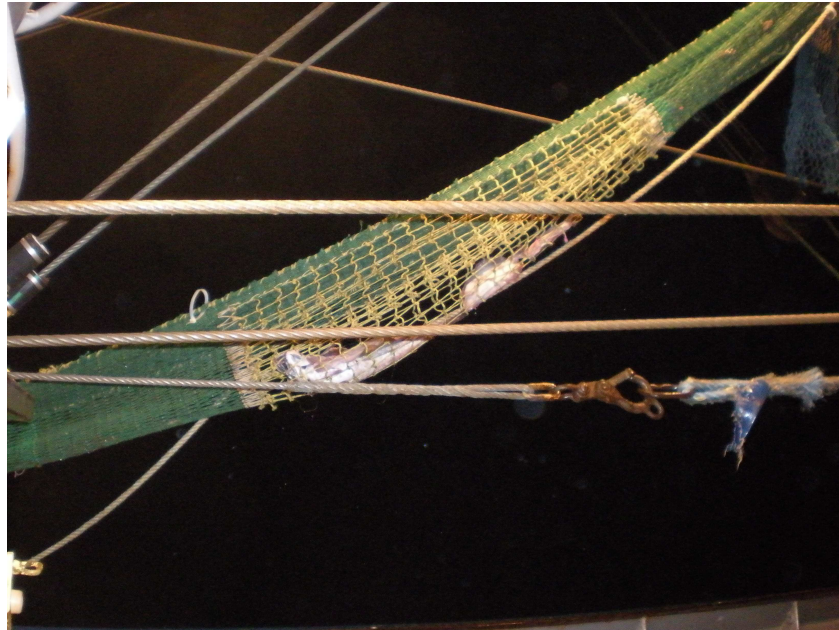
Figure 3: Photo of inserted panel

Figure 4: Catches stored in deck bins, port (left) and starboard (right), haul 16

Table 2-3: Data collection, sampling and measurement protocol

GROUP	SPECIES	SAMPLE minimal 1 basket, always weighed	MEASUREMENTS
Marketable fish (landings)	plaice (*Pleuronectes platessa* L.)	always from total unsorted catch, sub-sample when too numerous	length measurements
Undersized fish (discards)	plaice	from sample	length measurements

The data collection, sampling and measurement protocol is given in Table 2-3.

2.4   Data collection and analysis

Data on the conditions of each haul were recorded on paper sheets, among which: haul number, date-time shooting, date-time hauling, position shooting, position hauling, speed over ground, warp length, course, covered distance, water depth, wind speed, and wind direction. Fish data was recorded on paper sheets and typed in using data entry software Billie Turf™ version 6.2.1. together with the environmental data. These inputs were manually checked and SAS™-routines run to perform a range check.

Data analysis was performed using the SAS™ statistical package for which special codes were developed. Catches were converted to kg's and numbers per hour (CPUE) using the length-weight keys of Coull et al., 1989. Extracts of the mean values and standard errors were made for the categories: marketable plaice (landings), and undersized plaice (discards). A T-test was run on the log-transformed CPUE data using a 95% confidence interval.

3   Results

A total of 19 hauls were carried out at a towing speed around 3 knots in positions in the North Sea (Figure 5) in two gear tests, gear test 1 being the comparison of both sides with the by-catch reduction panels (BRPs) inserted, and gear test 2 the comparison of the test net (on the port side) with the panel, and the control net (on the starboard side) with the panel covered by normal netting (Table 3-1). Suspect hauls were haul 6, 16 and 18, while for haul 19 no length measurements were done. This haul was deleted for analyses therefore, and the effect of deleting the suspect hauls was investigated and is discussed in Chapter 5.

Table 3-1: Summary of trials in week 45, 2008

Haul	Gear test	Date	P gear test	S gear control	Objective	Comments
1 2	1	03/11/2008	With BRP	With BRP	T0 test to determine whether both nets fish equally	Both panels were inserted
3 … 19	2	04/11/2008 … 07/11/2008	With BRP	With BRP covered	Compare the catches with and without the BRP	The P-panel was covered with a sheet of normal netting

The mean catch of marketable plaice was almost equal in weight and a bit higher in number for the T0 comparison, but with only two hauls no statistical significance was found. The panel seemed to drop the catch rate somewhat, but again the result was not significant ($p > 0.05$), see Table 3-2. These results were calculated for the entire set of hauls, without deleting hauls that could be deemed as suspect.

Table 3-2: Catches of plaice > MLS in kg/hour and nr/hour

Gear test	MOD	No of hauls	Mean kg/hour		MOD/CON	Stderr kg/hour		p-value
			MOD	CON		MOD	CON	
1	T0	2	43.16	42.50	101.6%	6.28	1.14	0.974
2	BRP1	16	39.31	42.84	91.8%	4.02	4.28	0.122
Gear test	MOD	No of hauls	Mean nr/hour		MOD/CON	Stderr nr/hour		p-value
			MOD	CON		MOD	CON	
1	T0	2	158.17	143.85	110.0%	31.39	9.25	0.674
2	BRP1	16	141.12	149.18	94.6%	16.07	18.07	0.375

The mean catch of undersized plaice (discards) was reduced significantly both in weight (by 20.1%) and in number (by 23%), see Table 3-3. This is an important finding concerning the strive for reducing discards in coming years of this species particularly by the European Commission (Anon., 2007).

Table 3-3: Catches of plaice < MLS in kg/hour and nr/hour

Gear test	MOD	No of hauls	Mean kg/hour		MOD/CON	Stderr kg/hour		p-value
			MOD	CON		MOD	CON	
1	T0	2	19.10	21.58	88.5%	1.27	0.95	0.115
2	BRP1	16	**23.99**	**30.01**	**79.9%**	**4.14**	**5.17**	**0.007**
Gear test	MOD	No of hauls	Mean nr/hour		MOD/CON	Stderr nr/hour		p-value
			MOD	CON		MOD	CON	
1	T0	2	170.85	186.55	91.6%	9.15	5.45	0.170
2	BRP1	16	**212.83**	**276.46**	**77.0%**	**36.58**	**48.9**	**0.003**

The earnings from plaice catches were calculated with average prices for market grades of 2007 (Table 3-4). Although a drop of 10.8% is suggested, this result was not statistically significant (Table 3-5).

Table 3-4: Average price of plaice in €/kg per market grade in year 2007

Market grade	Length range (cm)	Price in €/kg
Plaice 1	L > 41	2.78
Plaice 2	35 < L ≤ 41	2.24
Plaice 3	31 < L ≤ 35	1.99
Plaice 4	27 < L ≤ 31	1.88

Table 3-5: Earnings from plaice > MLS in €/hour

Gear test	MOD	No of hauls	Mean €/hour		MOD/CON	Stderr €/hour		p-value
			MOD	CON		MOD	CON	
1	T0	2	72.90	74.26	98.2%	8.05	0.54	0.869
2	BRP1	16	66.35	73.90	89.8%	6.05	6.33	0.080

4   Discussion

Some of the hauls were a bit suspect because of fishing gear components being caught in one of the nets (See comments in Table 6-1). It was decided to investigate the effect of deleting these hauls. The effect on marketable plaice is given in Table 4-1 below, and does not change the conclusion, there were no significant differences for both gear tests.

Table 4-1: Catches of plaice > MLS in kg/hour and nr/hour, with suspect hauls (6, 16, and 18) deleted

Gear test	MOD	No of hauls	kg/hour					
			mean		MOD/CON	stderr		p-value
			MOD	CON		MOD	CON	
1	T0	2	43.16	42.50	101.6%	6.28	1.14	0.974
2	BRP1	13	37.76	42.13	89.6%	4.53	4.86	0.101
Gear test	MOD	No of hauls	nr/hour					
			mean		MOD/CON	stderr		p-value
			MOD	CON		MOD	CON	
1	T0	2	158.17	143.85	110.0%	31.39	9.25	0.674
2	BRP1	13	134.35	145.92	92.1%	17.92	20.92	0.270

The mean catch of undersized plaice (discards) was again reduced significantly both in weight (by 19.2%) and in number (by 20%), see Table 4-2. Here too our conclusion was not altered, the reduction in discards being significant both in weight and in numbers.

Table 4-2: Catches of plaice < MLS in kg/hour and nr/hour, with suspect hauls (6, 16, and 18) deleted

Gear test	MOD	No of hauls	kg/hour					
			mean		MOD/CON	stderr		p-value
			MOD	CON		MOD	CON	
1	T0	2	19.10	21.58	88.5%	1.27	0.95	0.115
2	BRP1	13	**23.70**	**28.64**	**82.8%**	**4.95**	**5.91**	**0.035**
Gear test	MOD	No of hauls	nr/hour					
			mean		MOD/CON	stderr		p-value
			MOD	CON		MOD	CON	
1	T0	2	170.85	186.55	91.6%	9.15	5.45	0.170
2	BRP1	13	**210.95**	**263.69**	**80.0%**	**43.8**	**55.94**	**0.021**

Deleting the suspect hauls gave more or less the same results, a lower income generated from marketable plaice, but again statistically non-significant (Table 4-3).

Table 4-3: Earnings from plaice > MLS in €/hour, with suspect hauls (6, 16, and 18) deleted

Gear test	MOD	No of hauls	€/hour					
			mean		MOD/CON	stderr		p-value
			MOD	CON		MOD	CON	
1	T0	2	72.90	74.26	98.2%	8.05	0.54	0.869
2	BRP1	13	64.23	72.94	88.1%	6.82	6.99	0.084

We found an indication of losses in marketable plaice from our samples. However, such losses were not confirmed by the skipper from his experience.

Van Keeken et al., 2004 reported on discard levels in the Dutch twintrawl fishery. The mean catch rates of plaice over a total of five sampled trips were <u>landings</u>: 191 individuals per hour, and 51 kg per hour; <u>discards</u>: 375 individuals per hour, and 47 kg per hour. In percentages this meant that on average 66% of the plaice were discarded in numbers and 47% in weight per hour. In addition they found no differences in discard survival between the twin trawl and beam trawl. The engine powers (range 300-600$^+$ hp) and mesh sizes used (range 80-100 mm) were larger than in our experiments, so these results are not completely comparable.

We compared the discard levels with data collected in the discard monitoring programme of IMARES. Numbers of fish discarded per hour in the fourth quarter of 2007 for the beam trawl vessels with an engine power larger than 300 hp using 80 mm cod-end mesh size were reported by Van Helmond and Van Overzee, 2008. For plaice in quarter four the average number <u>discarded</u> per hour was 579, and expressed in weight 49 kg per hour. The same numbers were for <u>landings</u> respectively 209 and 75, meaning a discard rate of 74% in number and 40% in weight. These values compare reasonably well with the values found here for both conventional and modified twin-trawl nets taken together for the case where suspect hauls were not omitted (Table 4-4).

Table 4-4: Discard figures for both twintrawl nets taken together

Plaice	kg/hour	nr/hour
landings CON	85.68	298.36
landings MOD	78.62	282.24
discards CON	60.02	552.92
discards MOD	47.98	425.66
% D/(L+D) CON	**41.2%**	**65.0%**
% D/(L+D) MOD	**37.9%**	**60.1%**

One may argue, that the difference in catching efficiency between the port and starboard net may bias the results. Geartest 1 was done to appraise such differences, but only contained two hauls. We calculated the fraction discards/(landings+discards) for both nets for the catches of plaice per haul expressed in kg/hour and numbers/hour. A t-test run on these fractions did not reveal statistical differences (P <= 0.05), so no hard evidence was found to infer a difference in the discard fraction of plaice between both nets.

5   Conclusions and recommendations

Inserting a By-catch Reduction Panel (BRP) in the twintrawl used on MFV TH-7 "Adriana Maria" reduced the by-catch of undersized plaice significantly by some 20%. This implies that the level of plaice discards over total catch would drop from 65% to 60% when both nets are fitted with a By-catch Reduction Panel, but this difference in discard over total catch (of plaice) fraction was not found significant.

There is no statistical evidence of a loss in marketable catch, although the numbers suggest a slight reduction, both in weight as in value. Nevertheless, a drop in earnings from the catches of marketable plaice of about 10% might occur, but this was not confirmed by the skipper from earnings records over a longer period.

Further studies might be considered on the possible reduction of by-catch of other fish and benthic species.

6 Other tables

Table 6-1: Trawllist with experimental conditions by gear test and haul

| gear test	haul	day	month	year	time	tow duration (min)	latitude shooting	latitude hauling	longitude shooting	longitude hauling	course (deg)	bottom track (m)	door spread (m)	warp length (m)	wind direction (deg)	wind force (B)	comments
1	1	3	11	2008	1045	210	54.13	54.24	4.36	4.4	15	20372	180	250	45	9	catchability check
	2	3	11	2008	1455	205	54.25	54.3	4.4	4.25	285	20372	180	250	45	7	
2	3	3	11	2008	1930	240	54.3	54.28	4.23	4.45	90	20372	170	250	90	7	comparison with/without BRP
	4	4	11	2008	0	240	54.28	54.16	4.42	4.38	180	22224	170	250	90	2	
	5	4	11	2008	430	240	54.16	54.28	4.35	4.41	15	22224	180	250	90	2	
	6	4	11	2008	900	210	54.28	54.17	4.41	4.37	180	20372	180	250	90	2	port aft net twisted, suspect haul
	7	4	11	2008	1315	240	54.17	54.29	4.38	4.4	10	22224	175	250	45	2	
	8	4	11	2008	1740	240	54.28	54.16	4.41	4.41	170	22224	170	250	45	4	
	9	4	11	2008	2215	240	54.16	54.28	4.4	4.38	10	22224	180	250	45	7	
	10	5	11	2008	250	240	54.29	54.33	4.4	4.27	270	22224	175	250	90	4	
	11	5	11	2008	725	205	54.33	54.29	4.27	4.43	115	18520	170	250	90	9	
	12	5	11	2008	1130	240	54.29	54.21	4.41	4.37	170	22224	180	250	90	9	
	13	5	11	2008	1615	180	54.19	54.13	4.34	4.28	260	17223	175	250	90	9	
	14	6	11	2008	1710	240	54.09	54.22	4.35	4.33	5	22224	175	250	180	7	
	15	6	11	2008	2145	240	54.23	54.28	4.32	4.47	80	22224	180	250	135	7	
	16	7	11	2008	230	240	54.28	54.19	4.44	4.28	225	22224	175	250	90	7	sweeps caught large netting piece, suspect haul
	17	7	11	2008	710	240	54.19	54.27	4.28	4.35	355	20372	170	250	135	7	
	18	7	11	2008	1200	240	54.27	54.16	4.34	4.33	180	22224	180	250	180	9	steel cable in port gear, suspect haul
2	19	7	11	2008	1650	240	54.15	54.04	4.32	4.33	180	22224	175	250	180	12	no length measurements taken, haul deleted from analyses

7 Other figures
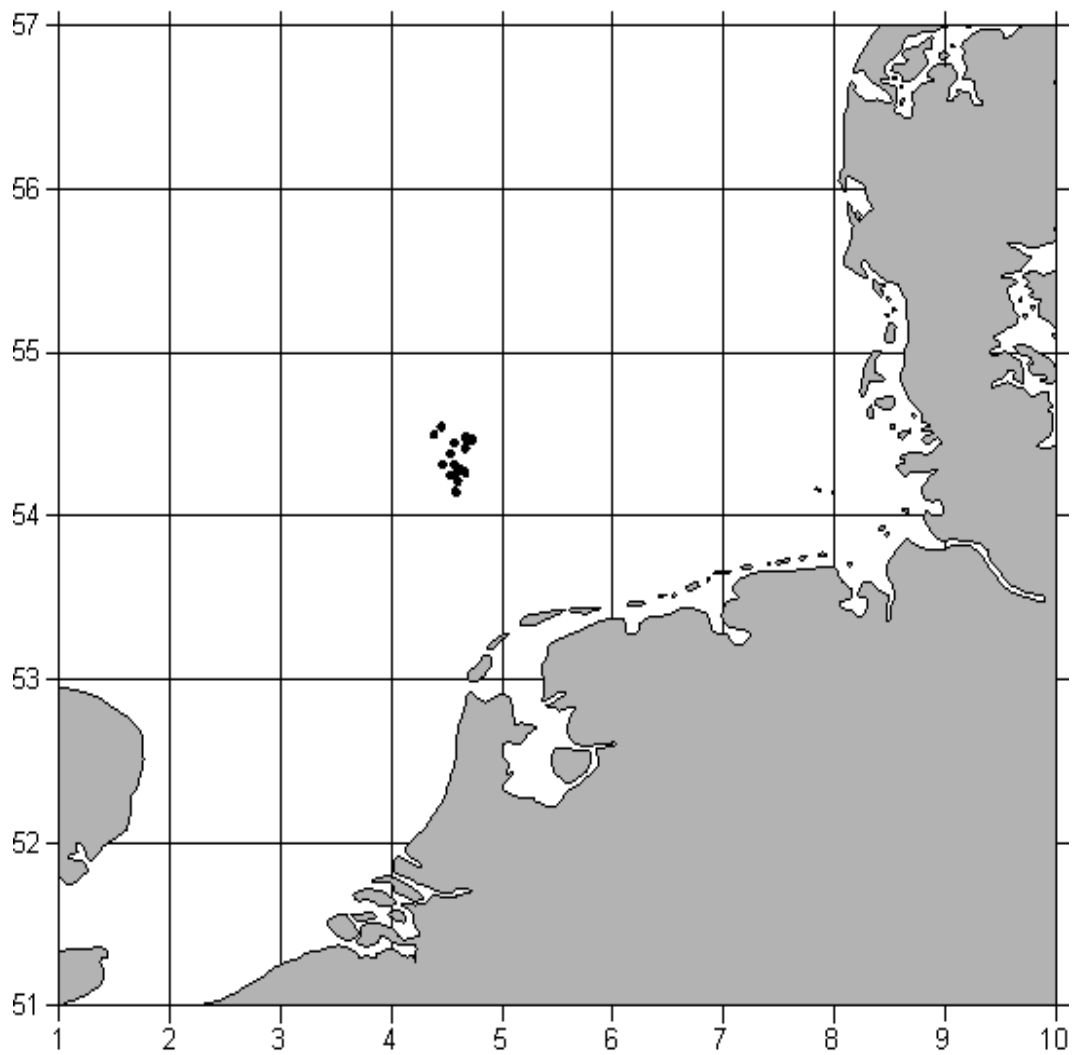
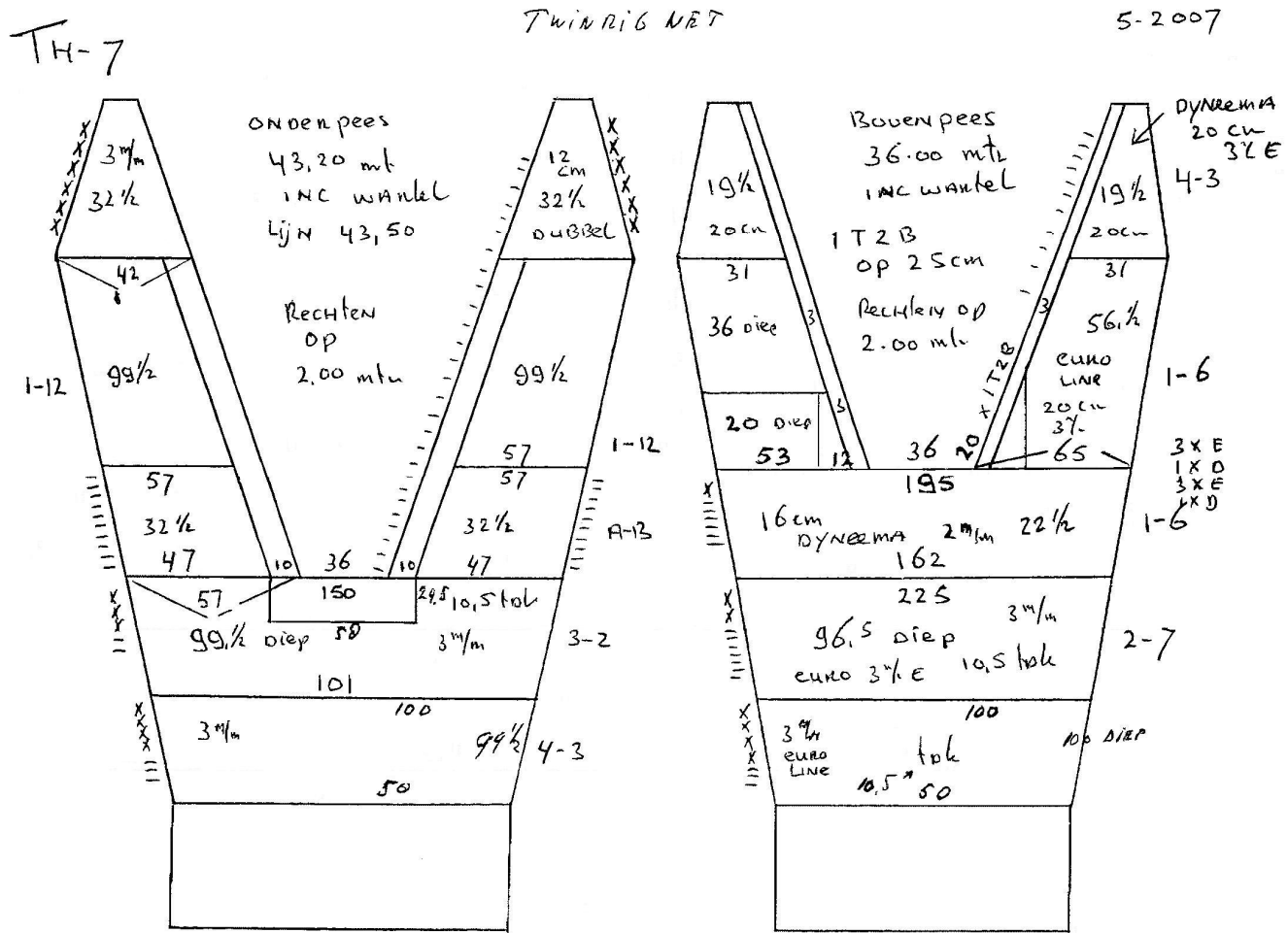Figure 5: Fished positions during the trials

Figure 6: Net drawing of gears used on MFV TH-7 "Adriana Maria"

8   Quality Assurance

IMARES utilises an ISO 9001:2000 certified quality management system (certificate number: 08602-2004-AQ-ROT-RvA). This certificate is valid until 15 December 2009. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. The last certification inspection was held the 16-22 of May 2007. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2000 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2009 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation, with the last inspection being held on the 12th of June 2007.

9   Acknowledgements

References

Anonymous, 2006. Vissen met tegenwind, Advies Task Force Duurzame Noordzeevisserij, April 2006, 47 p. (In Ducth)

Anonymous, 2007. A policy to reduce unwanted by-catches and eliminate discards in European Fisheries, Commission non-paper: COM (2007) 136 final

Bergman, M.J.N., van Santbrink, J., 1994. Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea. ICES J. Mar. Sci. 57 (5), 1321–1331.

Coull, K.A., Jermyn, A.S., Newton, A.W., Henderson, G.I. and Hall, W.B., 1989. Length/weight relationships for 88 species of fish encountered in the North East Atlantic. Scottish Fisheries Research Report No 43, 1989, ISSN 0308 8022.

Helmond A.T.M. van, and Overzee H.M.J. van, 2008. Discard sampling of the Dutch beam trawl fleet in 2007. CVO report, number: CVO 08.008.

ICES, 2001. Report of the Working Group on Ecosystem Effects of Fishing Activities. ICES CM 2001/ACME:09.

ICES, 2002. Report of the Working Group on Ecosystem Effects of Fishing Activities. ICES CM 2002/ACE:03.

Jennings, S., Kaiser, M.J., 1998. The effects of fishing on marine ecosystems. Adv. Mar. Biol. 34, 221–233.

Keeken, O.A. van, Quirijns, F.J., and Grift, R.E., 2004. Discards in de Nederlandse twinrigvisserij (In Dutch). RIVO Report, number C 011/04.

Lindeboom H.J., Groot, S.J. de (Eds.), 1998. The effects of different types of fisheries on the North sea and Irish sea benthic ecosystems. EU-project AIR2-CT94-1664 (IMPACT-II), Final Report ISSN 0923–3210, 404pp.

Marlen, B. van, 2000. Technical modifications to reduce the by-catches and impacts of bottom gears on non-target species and habitats. In: Kaiser, De Groot (Eds.), 2000. Effects of Fishing on Non-target Species and Habitats: Biological, Conservation and Socio-economic Issues. ISBN 0-632-05355-0, pp. 253– 268.

Piet, G.J., Rijnsdorp, A.D., Bergman, M.J.N., van Santbrink, J., 2000. A quantitative evaluation of the impact of beam trawling on benthic fauna in the southern North sea. ICES J. Mar. Sci. 57 (5), 1332–1339.

Justification

Report C106/08
Project Number: 439.15011.01

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

Approved: Dr. T. van Kooten
                   Researcher

Signature:

Date: 19/08/2009

Approved: Dr. ir. T.P. Bult
                   Head of Fisheries Department

Signature:

Date: 19/08/2009, revised 31/07/2009

Number of copies: 10
Number of pages   19
Number of tables: 12
Number of graphs: 6
Number of appendix attachments: 0