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Catch comparison of flatfish pulse trawls and a tickler chain beam trawl

B. van Marlen*, J.A.M. Wiegerinck, E. van Os-Koomen, E. van Barneveld

IMARES-Fishery part of Wageningen UR, P.O. Box 68, 1970 AB IJmuiden, The Netherlands

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ABSTRACT

Pulse trawling is used to a growing extent in the Dutch flatfish beam trawl fleet, and deemed as a promising alternative to tickler chain beam trawling. A comparative fishing experiment was carried out with one vessel using conventional beam trawls, and the other two using flatfish pulse trawls supplied by two different companies. Pulse trawl landings were lower both expressed in kg h^{-1} (67% based on auction data) or baskets per hectare (81%).

The pulse trawls had fewer fish discards (57%, $p < 0.0001$), including 62% undersized plaice (*Pleuronectes platessa* L.) ($p < 0.0001$), and 80% discarded weight of benthic invertebrates ($p = 0.0198$) per hectare. The pulse fishing technique resulted in a lower fuel consumption (37–49%), and consequently in spite of lower landings net revenues were higher. A downside of using pulse trawls is the possible spinal damage of marketable cod (*Gadus morhua* L.), but because total cod landings by beam trawls are low (4–5%), the implication will likely be limited.

1. Introduction

For many years there is concern about the impact of fishing on marine ecosystems. Particularly the use of towed gears and their effect on sensitive habitats and benthic fauna received attention (Jennings and Kaiser, 1998; Lindeboom and de Groot, 1998). Beam trawls are gears in this category that are intensively used in the North Sea fisheries of the Netherlands, Belgium, Germany, and the United Kingdom for catching brown shrimp (*Crangon crangon* L.) and flatfish, particularly sole (*Solea vulgaris* L.) and plaice. Beam trawling for flatfish is an efficient fishing method in terms of catches per unit of effort, but it requires a high level of energy input (typically 30,000–35,000 l of fuel/week), due to the high gear drag caused by the relatively heavy ground gear and high towing speeds (e.g. 6.5–7.0 knots, see Rijnsdorp et al., 2008). Consequently, this technique causes substantial mortality of undersized target fish, non-target fish, and changes in the species composition of invertebrates (Fonteyne and Polet, 2002; ICES, 1988; ICES, 1995; Jennings and Kaiser, 1998; Kaiser and De Groot, 2000; Lindeboom and de Groot, 1998; Piet et al., 2000). Paschen et al. (2000) reported that the penetration depth of tickler chain beam trawls varies between 10 and 80 mm, depending on the type of gear and substrate. Replacing tickler chains by electrical stimulation is seen as an alternative for diminishing the ecosystem effects of conventional beam trawling.

Research into the effects of flatfish pulse trawling using the Verburg (DELMECO) type of gear has been carried out by IMARES since 1998 by examining catch of target species, by-catch of undersized fish and benthos, and bottom impact, first with a 7 m prototype, then with a 12 m prototype beam trawl. The trials with the 7 m prototype showed that sole catches could reach the same level as in the conventional tickler chain beam trawl, but plaice catches reduced by about 50%. At the same time, catches of benthos were also reduced by ~50% (van Marlen et al., 1999, 2000). In addition it was found, that the median value of the direct mortality of benthic invertebrates could be reduced from 36% to 24% ($p = 0.09$) (van Marlen et al., 2001).

Using electricity in European fisheries is prohibited since 1988 through EC Regulation No. 850/1998, Article 3.1 (EU, 1998). The possibility of an introduction of electrical or pulse beam trawls in the flatfish fishery was considered by the European Scientific, Technical and Economic Committee for Fisheries (STECF) in 2006 and the International Council for the Exploration of the Sea (ICES) was asked to give advice. Questions were raised by ICES concerning changes in fishing mortality, species composition and the size of commercial fish species caught. ICES also wished to be informed about any effects of pulse trawling on non-target species that can come into contact with a pulse trawling gear in view of a widespread introduction of this technique. ICES was on the whole positive about the potential effects of the pulse trawl, but also raised some additional questions. The recommendation was given to conduct

* Corresponding author. Tel.: +31 317 487181; fax: +31 317 487326.
E-mail address: bob.vanmarlen@wur.nl (B. van Marlen).

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Table 1
Number of pulse trawlers in European member states, dated 01/01/2013.

Engine power	>300 hp		≤300 hp		Total
Country	Flatfish	Flatfish	Flatfish + shrimps	Shrimps	
Netherlands	25	13	1	3	42
Germany	3	1	0	1	5
United Kingdom	3	0	0	0	3
Belgium	0	0	0	1	1

Source of data: K. Taal, LEI, the Hague, the Netherlands.

further tank experiments to determine whether injury is being caused to fish escaping from a pulse trawl gear (ICES, 2006a,b,c,d). Following the ICES advice of 2006, IMARES conducted tank experiments on a range of fish and benthic species in 2007–2009 (de Haan et al., 2008; de Haan et al., 2009; van Marlen et al., 2009a; van Marlen et al., 2007), which were reviewed in 2009 and led to a renewed advice from ICES (ICES, 2009), followed up by additional tank experiments (de Haan et al., 2011; ICES, 2010, 2011, 2012). The occurrence of spinal damage in cod under some circumstances and future catch efficiency of pulse trawling were recognized as issues of concern, while the effects on sharks and invertebrates were deemed to be limited. Meanwhile in 2009 a total of 5% of the Dutch fleet was allowed to use pulse beam trawls (EU, 2009). This derogation worked on the basis of a maximum electrical power per unit beam length (1.25 kW/m), and a maximum effective voltage of 15 V on the electrodes.

The use of pulse trawling as an alternative to heavy tickler chains in sensitive Natura2000 areas has been advocated in policy documents recently, e.g. both in the Netherlands through the "Vibeg" agreement (Anon., 2012), as in Germany (Anon., 2011).

Since 2006 the development of pulse trawling systems continued, and new manufacturers entered the market. All research and evaluations carried out before 2011 were based on the specifications of the pulse trawls developed by Verburg Holland Ltd., Colijnsplaat, the Netherlands (recently acquired by the DELMECO-group, Goes, the Netherlands). Meanwhile, the 'PulseWing' was introduced in the Dutch beam trawler fleet by HFK Engineering, Baarn, the Netherlands, and so a new situation has emerged with two types of flatfish pulse trawl in use.

In January 2013 there were 51 vessels fishing with pulse trawls from various EU member states, i.e. the Netherlands, Germany, United Kingdom and Belgium. A total of 45 boats were fishing for flatfish, 1 for both flatfish and shrimp, and 5 for shrimp only. The vessel classes used are large beam trawlers (>300 hp), euro-cutters and shrimp trawlers (≤300 hp) (Table 1). They fish in ICES Area IV.

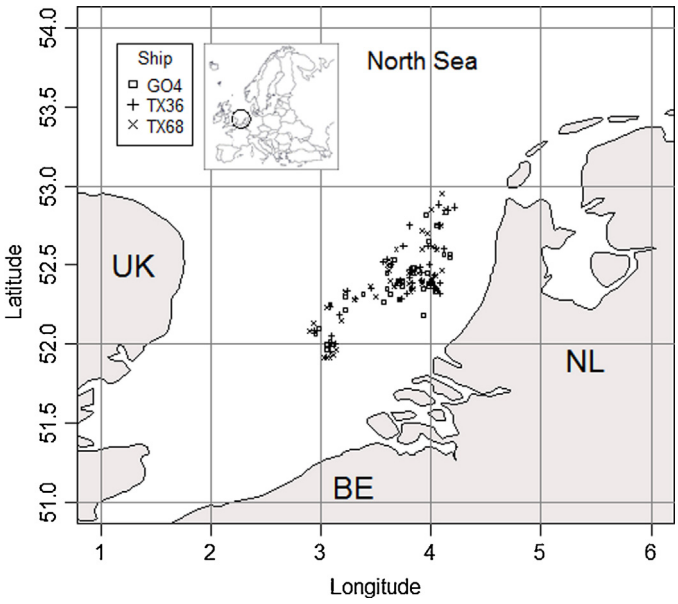

Fig. 1. Fishing positions of the three vessels in the North Sea during the catch comparison of 2011. BE = Belgium, NL = the Netherlands, and UK = United Kingdom.

This paper reports on a comparative fishing experiment in May 2011 between one commercial fishing vessel using traditional flatfish tickler chain beam trawls and two boats using either the DELMECO or the HFK flatfish pulse trawls. We were particularly interested to find out what the difference was between catches and by-catches of pulse trawls and a conventional beam trawl, the fate of cod in the pulse trawl catches, and their fuel saving potential. In addition, we compared differences in landings and discards of major target species, plaice and sole, and if they existed, whether they were length-related.

2. Materials and methods

2.1. Vessels

The fishing trials were conducted from the 5th to the 13th of May 2011 with three vessels (GO4, TX36 and TX68) fishing 'side-by-side' as much as possible given the differences in towing speeds (Fig. 1, Table 2). A total of was 45 hauls were done on-board the TX36 and the GO4, and 48 on the TX68, of which 33 hauls from each vessel were sampled for discards (Table 2). The TX36 was using HFK Pulse

Table 2
Main particulars of participating vessels, gears used and number of hauls carried out and sampled.

Vessel	GO4	TX36	TX68
Length o.a. [m]	40.11	42.35	41.15
Beam [m]	8.50	8.50	8.50
Depth [m]	4.71	5.15	5.30
Main engine power [hp]; [kW]	1995; 1467	1999; 1470	2000; 1471
Mean fishing speed [knots]	6.5	5.0	5.0
Gross Tonnage [GT]	417	494	438
Year built	1992	2000	1993
Fishing gear used	Tickler chain beam trawl 12 m	HFK Pulse wing 12 m	DELMECO pulse trawl 12 m
Cod-end mesh size [mm]	81.96 ± 2.68	80.75 ± 1.37	~80
Ground rope length [m]	34	36	32
Diameter discs on ground rope [mm]		200	240
Towing speed [knots]	6.44 ± 0.09 (6.5)	~5	5.0 ± 0.35 (5.0)
Total number of hauls	45	45	48
Number of hauls for which discards were sampled	33	33	33
Total number of hauls for which landings of plaice were sampled	32	15	13
Total number of hauls for which landings of sole were sampled	33	18	15