Pulse fisheries in the Netherlands

Economic and spatial impact study

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This study was carried out by Wageningen Economic Research and was commissioned and financed by the Dutch Ministry of Economic Affairs within the context of the '*verduurzaming visserij*' (improving the sustainability of fisheries) research theme of the Policy Support Research Tasks (project number BO-20-010-078)

Wageningen Economic Research
Wageningen, December 2016

REPORT
2016-104
ISBN 978-94-6343-011-1

Turenhout, M.N.J., B.W. Zaalmink, W.J. Strietman, K.G. Hamon, 2016. *Pulse fisheries in the Netherlands; Economic and spatial impact study.* Wageningen, Wageningen Economic Research, Report 2016-104. 32 pp.; 18 fig.; 1 tab.; 5 ref.

This study examines the economic consequences of the transition from beam trawl fisheries to pulse fisheries. It focuses on the economic results, fishing effort, fuel consumption, price of sole quotas and catch-based pay levels. It also examines the extent to which there has been a geographical displacement in fishing areas since the introduction of pulse technique.

Key words: pulse fishing, pulse technique, economic results, fuel consumption, displacement fishing areas

This report can be downloaded for free at http://dx.doi.org/10.18174/396469 or at www.wur.eu/economic-research (under Wageningen Economic Research publications).

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Wageningen Economic Research Report 2016-104 | Project code 2282600071

Cover photo: Bram Pronk

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Summary

S.1 Fishing with pulse technique has brought about a significant change in Dutch fishing industry

The transition to pulse fisheries has brought about economic consequences. Since its introduction, there has also been a geographical displace in fishing areas.

- The introduction of fishing with pulse technique has brought about a significant change in the Dutch fishing industry. From 2008 to 2014, 41 cutters switched from beam trawl fisheries to pulse fisheries, with a further 42 cutters making the transition in 2014. These cutters previously fished using the conventional beam trawl method.
- This change is also clearly seen in terms of fishing effort. Whereas beam trawling still represented 77% of total effort in terms of horse power days in 2008, this percentage fell to 2% in 2014. During the same period, the fishing effort of the pulse method and SumWing method rose to 68%.
- The transition from beam trawl fisheries to the cost-effective fisheries with pulse technique has made a significant contribution to the profitability of Dutch cutter fisheries. In 2014, for example, the net result of pulse fisheries amounted to approximately 17 million euros. Compare this to beam trawling, which just about broke even in the same year.
- The transition to the pulse method has considerably reduced the fuel consumption and CO_2 emissions of the cutter sector. In pulse trawling, fuel consumption per day at sea (>300 hp) is approximately 46% lower than in beam trawling.
- The transition to pulse fisheries has also caused a displacement to occur in the areas of the North Sea in which the Dutch cutter fleet fish. There are two reasons for this. First, it is now possible to fish in areas that were previously avoided by beam trawl fishermen. These are mainly areas with softer ground. Second, fishing with pulse technique focuses more on sole, whereas fishing with beam trawl technique focuses more on plaice. These two types of fish can be found in different areas. The result is a westward displacement in fishing areas more towards the English coast and a concentration off the Dutch and Belgian coasts as far as Katwijk.

S.2 Increase in profitability and catch-based pay

- Alongside positive results for the owners, the increase in profitability (higher catch proceeds and fuel savings) has also led to an increase in catch-based pay for the crew. In 2014, this increase amounted to approximately €30,000 per crew member per year.
- Fishing with Pulse technique is particularly efficient when fishing for sole, as it enables much more profitable sole to be caught. When quotas for sole are inadequate, it is possible for these to be leased. There has therefore been a strong increase in demand for sole quotas and, consequently, in the lease price for these quotas. This price rose from 60 eurocents per kg in 2012 to €3.38 per kg in 2015. Although this higher lease price is affordable for the fisheries with pulse technique, it leads to financial problems for small-scale fisheries that normally lease an additional sole quota.

S.3 Method

The request made by the Dutch Ministry of Economic Affairs was to identify the importance of pulse fisheries for the Dutch fleet, what contribution it makes to the economic results of the cutter fleet and to what extent there have been displacements in fishing areas since fishing with pulse technique was introduced.

An analysis and description are given of the economic performance of the Dutch cutter fleet based on information provided by Wageningen University & Research's Fisheries Accountancy Data Network. Additionally, the VIRIS database provides insight into the fishing areas and fishing periods per cutter and consequently reveals any displacements in fishing areas for the sector as a whole.

1 Introduction

1.1 Background

Since 2009, there has been a significant change in the Dutch cutter fleet in terms of the fishing methods used in flatfish fishing (plaice and sole) and, to a lesser extent, in shrimp fishing. The fisheries with pulse technique and SumWing technique have largely replaced conventional beam trawling. This change has led to various consequences and effects on costs and revenues and also resulted in displacements in key catch areas.

1.2 Purpose

The purpose of this report is twofold. On the one hand, we provide an overview of the economic effects of the transition from fishing using the beam trawl technique to fishing using the SumWing and pulse techniques. We do so by examining themes such as composition, effort and landings, as well as cost structure and economic results. On the other hand, we describe the spatial displacements that have occurred in the fishing areas. However, we do not discuss ecological aspects, as these are covered in other studies forming part of the policy support research.

1.3 Material and method

The information that forms the basis of the analyses in the first part of the report was drawn from datasets managed by the Dutch Ministry of Economic Affairs and by Wageningen Economic Research. The following information was used for this purpose:

- Landings data from the official logbooks (VIRIS)
- Technical data from the ships in the Dutch national fishing fleet register (NVR)
- Position data (VMS data) for ships
- Economic data from Wageningen Economic Research's Fisheries Accountancy Data Network

Other sources of data (as indicated in the text) were also used for specific aspects.

The information used for the analysis of geographical distribution is based on VMS and logbook data. Information on fishing effort (horse power days) was also used to examine whether a displacement in fishing areas occurred between the periods 2008-2009 (prior to the introduction of pulse trawling) and 2014-2015 (by which time pulse trawling had become commonplace). Please refer to Chapter 4.1 for a description of the method used.

2 Active Dutch cutter fisheries

2.1 General

Number of active cutters
In 2015, 549 Dutch vessels were engaged in fishing activities to some extent. Of these vessels, 279 were active; one less than in 2014 (baseline date: 31 December). An active vessel – here referred to as 'cutter' – is assumed to be at least twelve metres in length and have a landing value of at least 50,000 euros.

Engine power
Engine power is used as an indicator of cutter type. A distinction is made between cutters with an engine power greater than 300 hp (>300 hp) and cutters with an engine power of 300 hp or less (<=300 hp). Cutters with an engine power of 300 hp or less are generally smaller (in terms of length, storage capacity and gear and crew members) when compared to cutters with an engine power greater than 300 hp. Furthermore, cutters with an engine power of 300 hp or less are allowed to fish within the twelve-mile zone under certain conditions.

Engine powers are registered in the National Fishing Fleet Register (NVR). Of the 279 active cutters, 85 had an engine power greater than 300 hp and the remaining 194 cutters had an engine power of 300 hp or less (see Table 2.1).

Table 2.1 *Vessels with major types of fishing gear (based on landing value) in the Dutch active cutter fleet in 2015*

Type of gear	<=300 hp	>300 hp
Beam/SumWing/Pulse	16	67
Flyshoot	1	12
Otter boards/Twin rig/Quad rig	17	6
Shrimps	160	0
Total	194	85

Source: VIRIS; NVR (baseline date for the fleet: 31 December).

Table 2.1 shows that of the 85 cutters with an engine power above 300 hp, 67 of them (79%) obtained most of their landing value from flatfish catches using beam trawl, SumWing and pulse fishing gear. Twelve cutters obtained most of their landing value from flyshoot fishing and six others from otter board, twin rig or quad rig trawling. Of the 194 cutters with an engine power of 300 hp or less, 160 of them (82%) obtained most of their landing value from shrimp fishing. Seventeen cutters obtained most of their landing value from otter board, twin rig or quad rig trawling; sixteen cutters from flatfish fishing using beam trawl, SumWing or pulse gear; and one cutter from flyshoot fishing.

Fishing gear categories in cutter fisheries

Beam/SumWing/Pulse fisheries
Fishing based on the beam trawl, SumWing and pulse techniques predominantly focuses on flatfish (sole and plaice). These types of fishing can be characterised as follows:

- In *beam trawl fisheries*, two nets on either side of the vessel are dragged along the seabed. A 'beam' is used to keep the nets open across the width. Metal link chains ('tickler chains') hang behind this beam to disturb the fish from the seabed and guide them into the net.
- In *SumWing fisheries*, the traditional beam is replaced by a 'wing'. This profile has a hydrodynamic shape which glides through the water. This technique also uses tickler chains.

- In *pulse fisheries*, a ‘beam’ or ‘wing’ is also used, but the tickler chains are replaced by rubber coated cables containing modules which emit electric pulses to shock fish up from the seabed. This guides the fish into the net. Relatively more sole is caught using this technique than with the SumWing and beam trawl techniques.
- The above-mentioned fishing techniques are used by both small cutters (300 hp) and large cutters (>300 hp).

Flyshoot fisheries
- In flyshoot fisheries, a long cable or line (seine rope) with a net in the middle is dragged behind the cutter along the seabed in a large loop. The seine rope rolls across the seabed producing dust clouds that startle the fish and ensure that the fish – particularly those that are large and strong – keep swimming in front of the ropes. During fishing, the loop of the seine rope is pulled closer and closer together and gradually pulled towards the cutter. This is how the fish are herded into the net opening.
- Flyshoot technique is used to catch species such as mullet, gurnard, squid, sea bass, plaice and common dab.
- Most cutters in this category have an engine power above 300 hp.

Otter board / Twin rig / Quad rig fisheries
- In otter board, twin rig and quad rig fisheries, fishing is carried out using one, two or four trawl nets. Otter boards are attached to the two outer sides of each net that ‘pull’ the net open during fishing. The nets are dragged forwards at a relatively slow speed, causing the fish to swim out in front of the cables and eventually end up in the net.
- This technique can be used to catch flatfish, roundfish, species such as gurnard and mullet, as well as langoustines.
- This type of fishing is done with both small cutters (<= 300 hp) and large cutters (>300 hp).

Shrimp fisheries
- In shrimp fisheries, two relatively light, finely-meshed trawler nets are dragged across the seabed to catch shrimps.
- Shrimp fishing is mainly carried out in coastal waters. Besides the Dutch coastal waters and the Wadden Sea, these also include the German, Belgian and Danish waters on the side of the North Sea.
- The cutters have a maximum engine power of 300 hp.

Effort
Fishing effort is determined based on the number of horse power days. The engine power is multiplied by the number of days that the cutters are at sea. The number of horse power days is a measurement unit to determine the level of effort (fishing intensity) per type of ship (a 300 hp cutter has a different intensity per day at sea than a 2,000 hp cutter). The extent of the effort is determined on the basis of the engine power as registered in the National Fishing Fleet Register.

Figure 2.1 shows that the total effort of the cutter fleet has been gradually decreasing since 2008, down to 34.1 million horse power days in 2014. This decrease is partially due to the decline in the number of cutters (particular large cutters >1,500 hp) within the fleet.

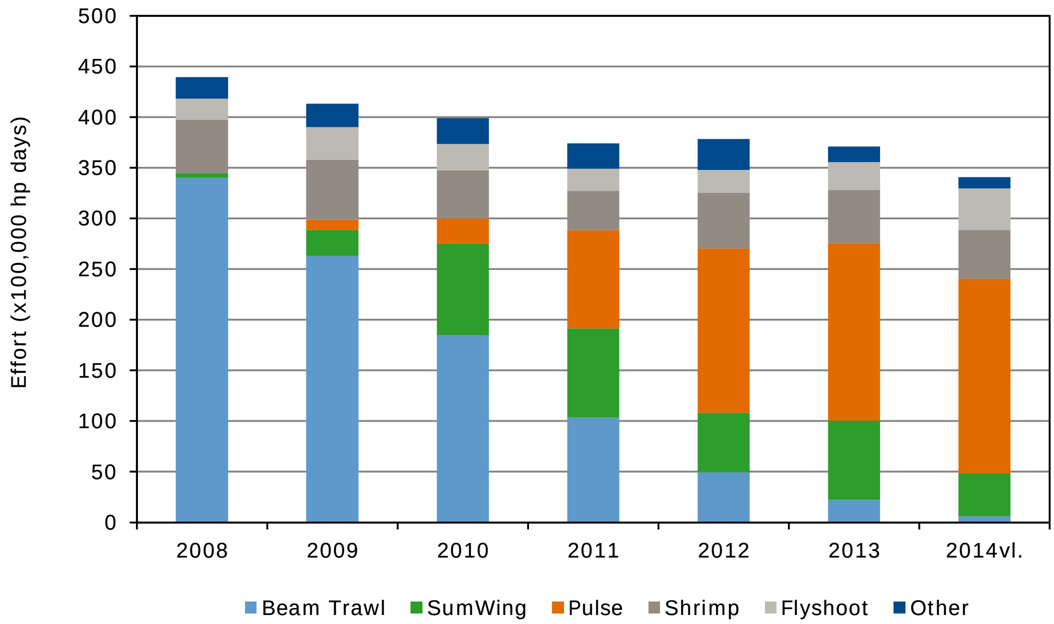

Figure 2.1 *Effort of the Dutch cutter sector in horse power days, 2008-2014*
Source: www.agrimatie.nl

In 2014, the largest proportion of the total effort was determined by pulse fisheries (56%), followed by shrimp fisheries (14%), SumWing fisheries (12%) and flyshoot fisheries (12%), other fisheries (particularly otter board trawling 3%) and beam trawl fisheries (2%). The figure shows a clear movement away from beam trawl fisheries to alternative forms of fisheries such as SumWing and pulse fisheries.

Landings
In 2015, the total landings of the Dutch active cutter fleet were 81.3 million kg in live weight (Figure 2.2). In recent years, the landings have been at around this level. The largest part of these landings consists of plaice, sole and shrimps. A smaller part consists of fish species such as common dab, turbot, brill, red gurnard and langoustine.

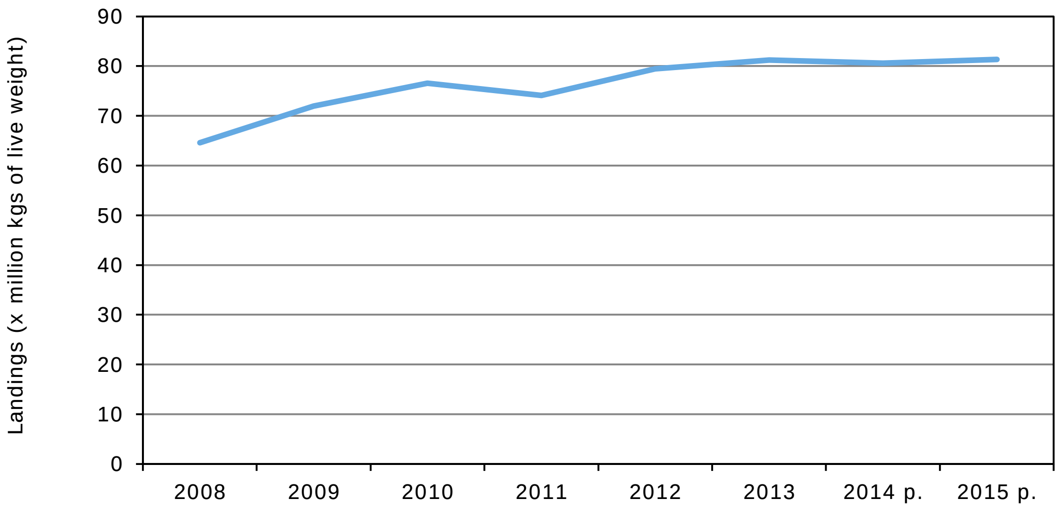

Figure 2.2 *Landings (live weight) of the Dutch cutter sector, 2008-2015*
Source: VIRIS.

In 2015, the largest part of the landings (live weight) was produced by beam trawl, SumWing and pulse fisheries, which made up over 55% of the total (44.9 million euros). In the same year, shrimp fisheries, flyshoot fisheries and otter board, twin rig and quad rig fisheries contributed 24% (19.3 million kg), 11% (9.2 million kg) and 10% (7.7 million kg) to the landings respectively.

2.2 Beam trawl, SumWing and pulse fisheries

Innovations in fishing gear such as the SumWing and pulse techniques meant that flatfish could be caught using methods that are more energy efficient and therefore more cost effective. This is the reason why most of the fleet has since switched from fisheries with beam trawltechnique to these new fishing techniques.

Effort

In 2008 – the year before the fisheries with pulse technique was introduced – beam trawling still accounted for 77% (34.0 million hp days) of the total fishing effort (44.0 million hp days), but this decreased to 2% (1.0 million hp days) by 2014. During the same period, there was a significant increase in the effort of pulse fishing and SumWing fishing, which have largely replaced fishing with conventional beam trawling equipment. The combined effort of SumWing and pulse fisheries accounted for 68% of the total effort – 12% (4.2 million hp days) and 56% (19.2 million hp days) respectively.

Number of exemptions in the Netherlands for pulse trawling

In 2015 it is still not permitted in the European Union to catch fish using electricity (EU Regulation 850/98). As studies into pulse fisheries have shown promising results, all EU member states have been permitted since 2006 to fish in the southern part of the North Sea with a temporary exemption for pulse fisheries (Annex III(4) EU Regulation 41/2006). These are the ICES areas IVb and IVc to the south of 55◦NL, to the west of 5◦EL, and to the south of 56◦NL, to the east of 5◦EL. The maximum number of exemptions that can be allocated on the basis of this regulation represents 5% of the (beam trawling) fleet of the member state (Kraan et al., 2015; Quirijns et al., 2014).

In the Netherlands, a number of fishermen started using the pulse technique in 2009. Whilst there were still only four exemptions granted in 2009, this figure had risen to 84 by 2015. By 2014, an exemption had been granted to 42 cutters. In 2014, an extra 42 exemptions were granted for both flatfish and shrimps. These two groups of exemptions have been granted on the condition that the pulse technique is studied and developed further and used on a wider scale. These extra exemptions are based on Article 14 of the Basic Regulation of the Common Fisheries Policy (1380/2013). These exemptions allow for pulse fishing to be undertaken in the ICES areas IVb and IVc to the south of 55◦NL.

Of the 84 exemptions, 27 were granted to cutters <=300 hp (flatfish and/or shrimps) and 57 to cutters >300 hp. Of the 84 exemptions, six of them were not used in 2015. Seventy-four cutters use the pulse technique to catch flatfish and five cutters use the pulse technique to catch common shrimp. The pulse gear comes from three suppliers: HFK engineering (79%) and Delmeco BV (15%) for flatfish pulse gear and Marelec (6%) for shrimp pulse gear.

Landings

As mentioned in Chapter 2.2.5, beam trawl, SumWing and pulse fisheries were responsible for more than 55% of the total landings of the cutter fisheries in 2015 (81.3 million kg) with landings in that year of almost 44.9 million kilograms of fish and shrimps; 9% more than in 2014 (41.2 million kg; Figure 2.3). The largest proportion of the landings (75-80%) in this category consists of plaice and sole. Other frequently caught fish species are common dab, turbot, brill and red gurnard.

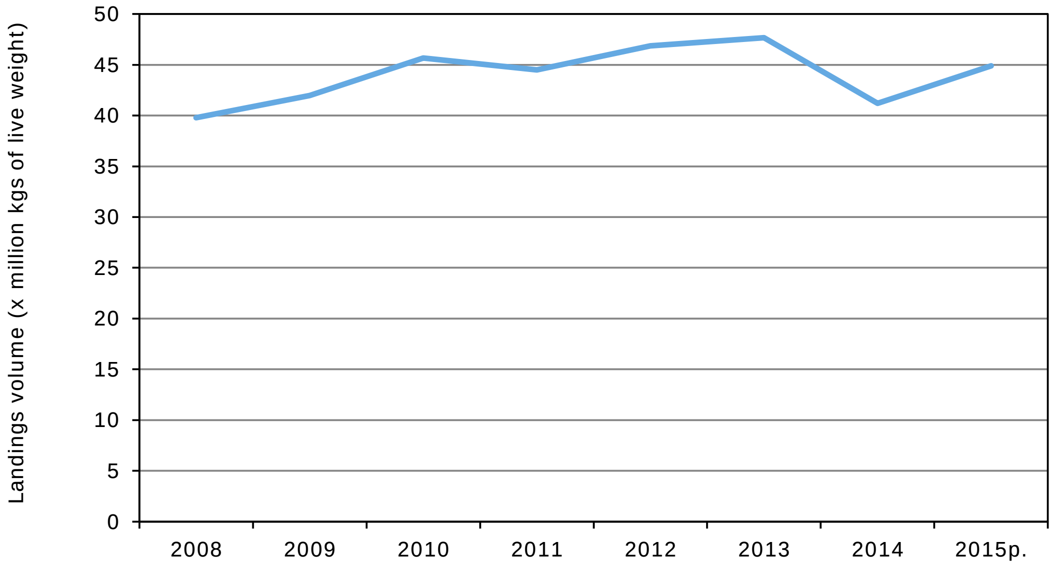

Figure 2.3 *Landings (live weight) from Dutch beam trawl, SumWing and pulse fisheries, 2008-2015*
Source: VIRIS

Figure 2.4 shows the landings of fish per day at sea for the active <=300 hp and >300 hp cutters using beam trawl, SumWing and pulse technique. The size of the landings depends partly on the fishing technique used, the size of the mesh and the extent of the fish stocks, particularly in the North Sea. In 2015, the average landings per day at sea for large cutters (>300 hp) was, at 4,340 kg, highest in beam trawl/SumWing fisheries with mesh size of 100+ mm, followed, at 3,174 kg, by beam trawl/SumWing fisheries with a mesh size of around 80 mm. The fish landed per day at sea in 80 mm pulse fisheries amounted to an average of 2,626 kg.

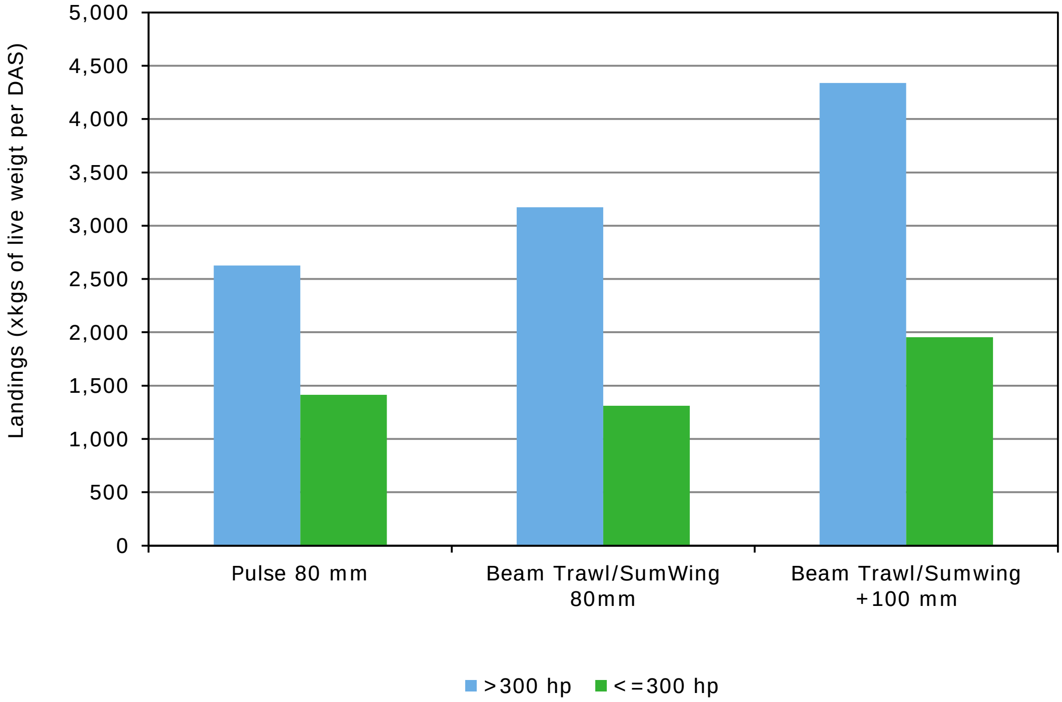

Figure 2.4 *Landings per day at sea (live weight) Dutch 80 mm pulse, 80 mm beam trawl/SumWing and 100+ mm beam trawl/SumWing fisheries, preliminary figures for 2015*
Source: VIRIS.

In 2015, the landings per day at sea for the <= 300 hp cutters was also highest in beam trawl/SumWing fisheries with a 100+ mm mesh, with an average of 1,955 kg per day at sea. The amounts of fish landed per day at sea in the pulse and beam trawl/SumWing fisheries using 80 mm mesh were not that far apart, with an average of 1,414 kg and 1,311 kg respectively per day at sea.

The 80 mm mesh is mainly used in mixed flatfish fisheries for sole and plaice. When fishing focuses solely on plaice, nets with a mesh size of +100 mm are used. The amount of fish landed is mainly determined by the plaice, which is why total catches are also highest in +100 mm mesh fishing.

Despite the relatively low overall average of landings per day at sea, most of the sole is landed in 80 mm pulse fisheries (Figure 2.5). In 2015, the high catchability of sole using the pulse technique resulted in average landings of 709 kg of sole per day at sea for large >300 hp cutters, which represents 27% of the total landings in this category. The amount of sole landed in 80 mm and 100+ mm beam trawl/SumWing fisheries was somewhat lower, at around 426 kg (13% of the total) and 209 kg (5% of the total) respectively in the same year. In <=300 hp pulse fisheries, sole accounted for 40% of the total catch, amounting to 564 kg per day at sea. In 80 mm and 100+ mm beam trawl/SumWing fisheries, sole accounted for only 18% (233 kg per day at sea) and 2% (49 kg per day at sea) respectively of the total catch.

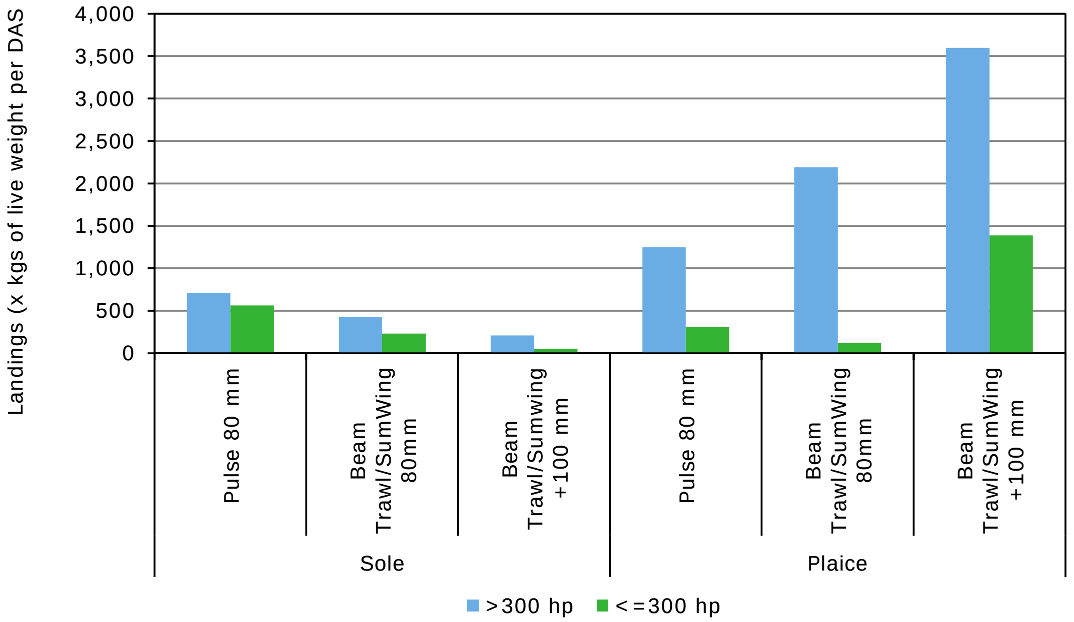

Figure 2.5 *Landings of sole and plaice per day at sea (live weight) in Dutch 80 mm pulse, 80 mm beam trawl/SumWing and 100+ mm beam trawl/SumWing fisheries, preliminary figures for 2015 Source: VIRIS.*

Figure 2.5 shows that the total plaice landings by the 100+ mm beam trawl/SumWing fisheries >300 hp amounted to 3,597 kg per day at sea in 2015, which is 83% of the total landings of all fish within this segment (see Figure 2.4). In this same segment, the <=300 hp cutters landed 1,387 kg of plaice per day at sea which represents 71% of the total landings. The >300 hp 80 mm beam trawl/SumWing and pulse cutters landed 2,191 kg (69% of the total) and 1,248 kg (48% of the total) respectively per day at sea in 2015; the <=300 hp cutters landed 121 kg (9%) and 310 kg (22%) respectively.

2.3 Economic results

2.3.1 Costs

In 2014, the total costs for the entire Dutch active cutter fleet amounted to 206 million euros, of which 112 million euros were accounted for by beam trawl, SumWing and pulse fisheries. The total costs in this last category fell between 2008 and 2014 from 164.1 million euros to 112 million euros in 2014 (see Figure 2.6). The main reasons for this are the reduction in the fleet (decline in the number of days at sea) and the decrease in fuel consumption resulting from the transition to more energy-efficient fishing methods such as fisheries using SumWing and pulse techniques.

In 2013, the total costs for beam trawl, SumWing and pulse fisheries were 16% higher than in 2014 at around 133 million euros (Figure 2.6). In particular, there was a considerable 32% decrease in fuel costs, from 44.4 million euros in 2013 to 30.2 million euros in the following year. In 2014, fuel costs and labour costs accounted for 27% (33% in 2013) and 31% (25% in 2013) of total costs respectively.

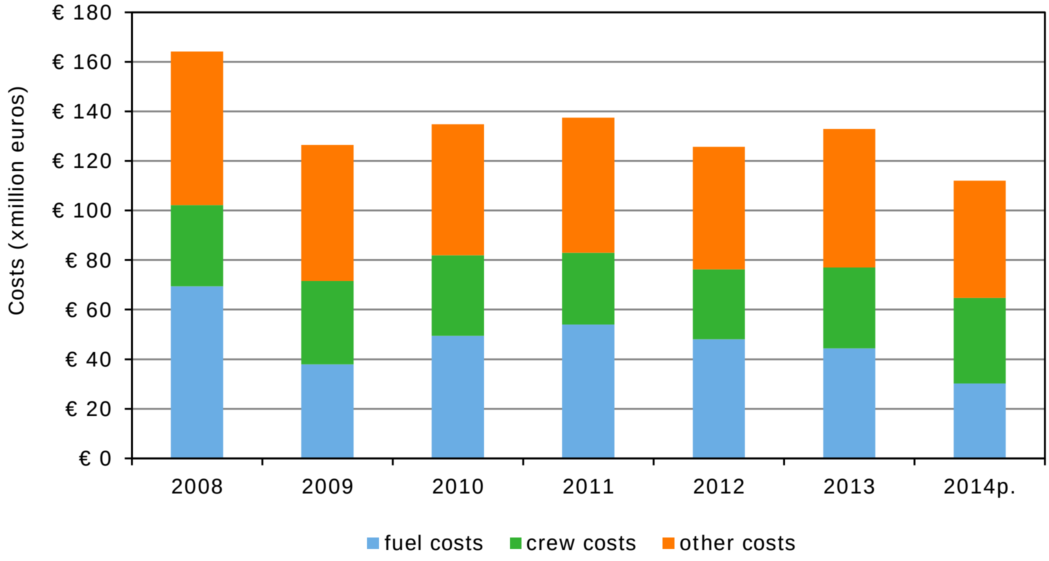

Figure 2.6 *Costs of Dutch beam trawl, SumWing and pulse fisheries, 2008-2014*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

If we focus on pulse fisheries, then the costs in 2014 amounted to almost 93 million euros. The share of fuel costs as a percentage of the total costs is substantially lower with this more energy-efficient fishing technique (24% in 2014) when compared to beam trawl and SumWing fisheries (40% in 2014). By contrast, the percentage of the costs for catch-based pay and social security charges is significantly higher in pulse fisheries (27% in 2014) than in beam trawl and SumWing fisheries (24% in 2014). We will return to this topic later.

Below, we explain in greater detail the main cost factors in flatfish fisheries using beam trawl, SumWing and pulse techniques; these are fuel costs, labour costs (including catch-based pay) and other costs (quota leases).

Fuel costs
Fuel costs per day at sea within the Dutch fishing industry are partly determined by the type of fishing gear used and the fuel price. The price of fuel has risen considerably since the beginning of 2000. Whereas a litre of fuel cost less than 15 cents on average in the years prior to 2000, the average price had risen to 66 cents by 2012 (highest level). Since 2012, the average price for fuel has been falling again to an average of 41 cents in 2015 (Figure 2.7).

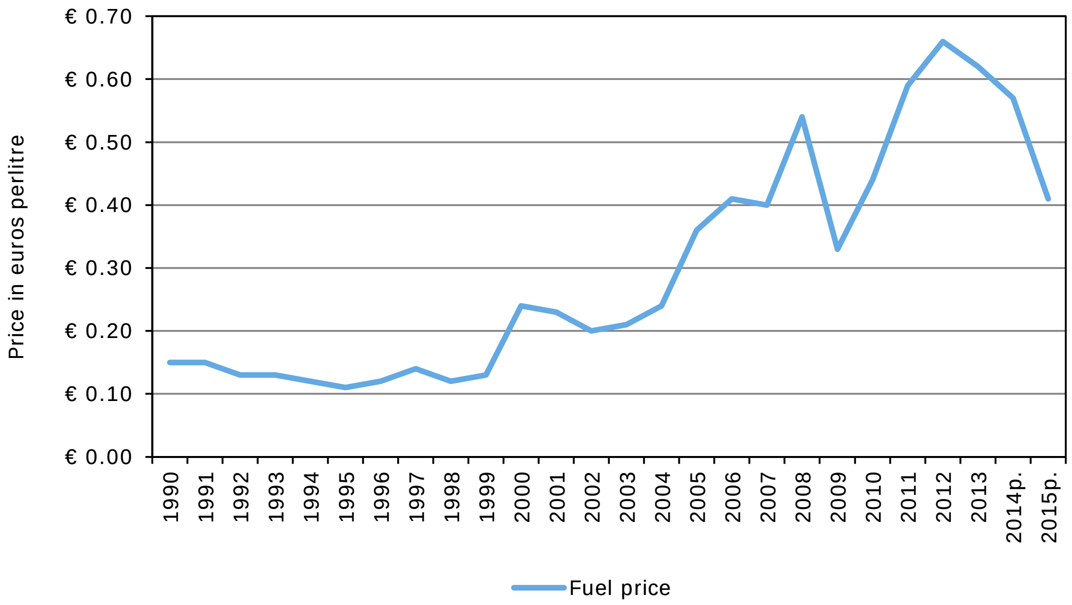

Figure 2.7 *Average fuel price in the Dutch cutter sector, 1990-2015*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Figure 2.8 shows the fuel consumption and fuel costs per day at sea for the >300 hp beam trawl, SumWing and pulse fisheries. It shows that:

- Fuel consumption per day at sea is significantly lower in pulse fisheries than in traditional beam trawl fisheries. Whereas an average of more than 7,600 litres are consumed per day at sea in beam trawl fisheries (2009-2014 average), fuel consumption in pulse fisheries decreases by 46% to an average of 4,100 litres per day at sea (2009-2014 average).
- Fuel consumption in SumWing fisheries is around 6,200 litres per day at sea on average, which is 18% lower when compared to beam trawl fisheries.

This decrease in fuel consumption is partly due to the lower resistance produced by the innovative fishing gear, as the equipment is lighter and creates less disturbance on the seabed. In addition, cutters fish at lower speeds in pulse fisheries (around 5.5 knots on average) than in beam trawl and SumWing fisheries (around 6.6 knots on average) (Poos et al., 2013).

Fuel savings and CO_2 reduction in >300 hp cutters

The switch from fisheries with beam trawl technique to fisheries with pulse technique produces fuel savings of 650,000 litres per year (for an average >300 hp cutter with 185 days at sea). If the 57 large cutters in possession of a pulse licence were to make the full transition to pulse fisheries, fuel savings would increase to 37.1 million litres a year. Based on fuel consumption alone, this would result in a reduction in CO_2 emissions of 100.1 million kilograms
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

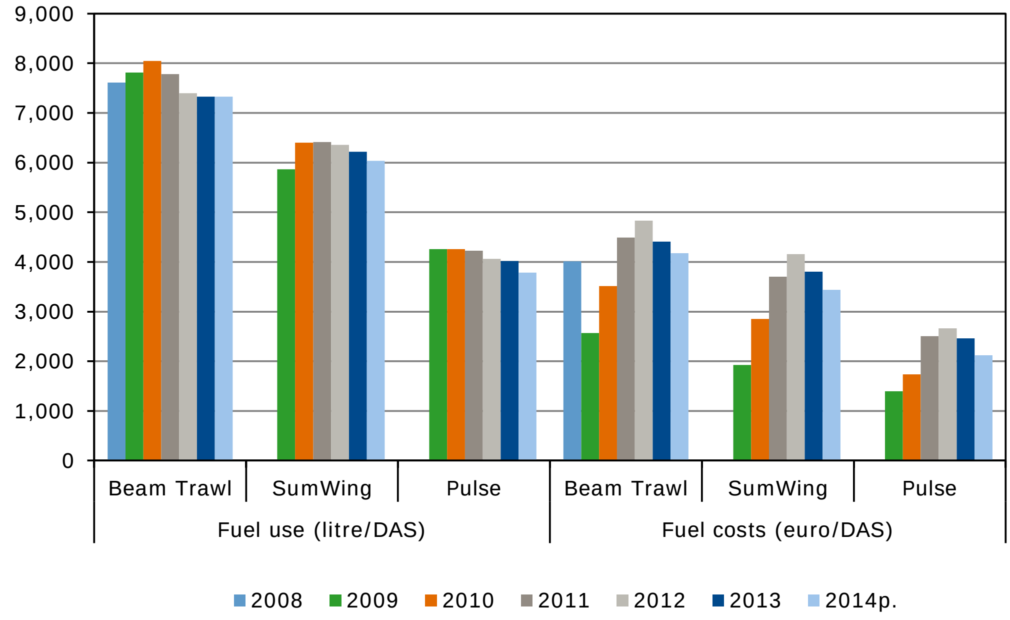

Figure 2.8 *Fuel consumption and costs per day at sea (DAS) for >300 hp beam trawl, SumWing and pulse fisheries, 2008-2014. For reasons of privacy, the fuel consumption figures for beam trawl fisheries have been combined for 2013 and 2014, and the same applies to pulse fisheries for 2008 and 2009*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

The difference in fuel consumption between pulse fisheries and beam trawl fisheries is smaller among the <=300 hp cutters than among the >300 hp cutters (see Figure 2.9). Fuel consumption per day at sea for pulse fisheries is 12% lower than for beam trawl fisheries, at 1,673 litres per day at sea (average for 2011-2014). In beam trawl fisheries, consumption amounts to 1,911 litres per day at sea (average for 2009-2014).

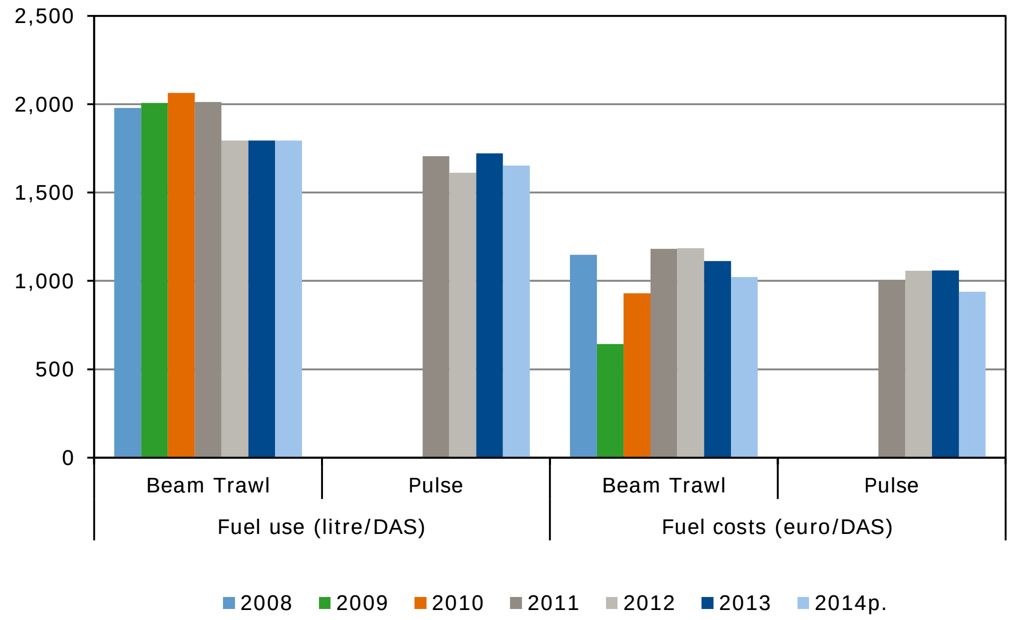

Figure 2.9 *Fuel consumption and costs per day at sea (DAS) for Dutch <=300 hp beam trawl, SumWing and pulse fisheries, 2008-2014. For reasons of privacy, the fuel consumption figures for beam trawl fisheries have been combined for 2012, 2013 and 2014, and the same applies to pulse fisheries for 2011 and 2012*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Fuel costs per day at sea are dependent upon the price of fuel (Figure 2.10). In 2014 (with an average fuel price of 57 cents), the fuel costs per day at sea for the >300 hp beam trawl, SumWing and pulse fisheries were 4,412 euros, 3,439 euros and 2,122 euros respectively. In the <=300 hp beam trawl and pulse fisheries, the fuel costs per day at sea were 1,023 euros and 939 euros respectively in the same year. The fuel costs per day at sea are expected to decrease in 2015 for the different fishing techniques due to the fall in fuel price (41 cents on average in 2015).

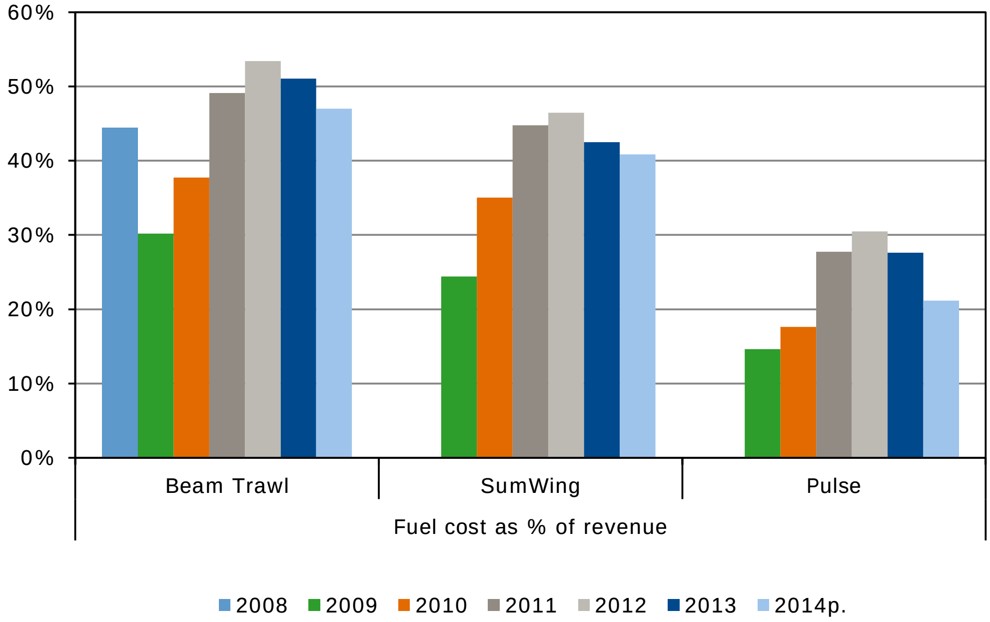

Figure 2.10 *Fuel costs as a percentage of the gross landings value in large-scale (>300 hp) Dutch beam trawl, SumWing and pulse fisheries, 2008-2014. For reasons of privacy, the fuel costs as a percentage of the gross landings value have been combined for beam trawl fisheries for 2013 and 2014, and the same applies to pulse fisheries for 2008 and 2009*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Together with the crew costs, the fuel costs largely determine the profitability of the cutter sector. In the >300 hp beam trawl and SumWing fisheries, fuel costs constitute the main cost factor; in 2014 these accounted for 51% and 41% respectively of the total gross landings value. In the >300 hp pulse fisheries, fuel costs were considerably lower; in 2014 these costs accounted for 21% of the total landings value (Figure 2.10). In the <=300 hp beam trawl and pulse fisheries, fuel costs accounted for 28% and 15% respectively of the total gross landings value (Figure 2.11).

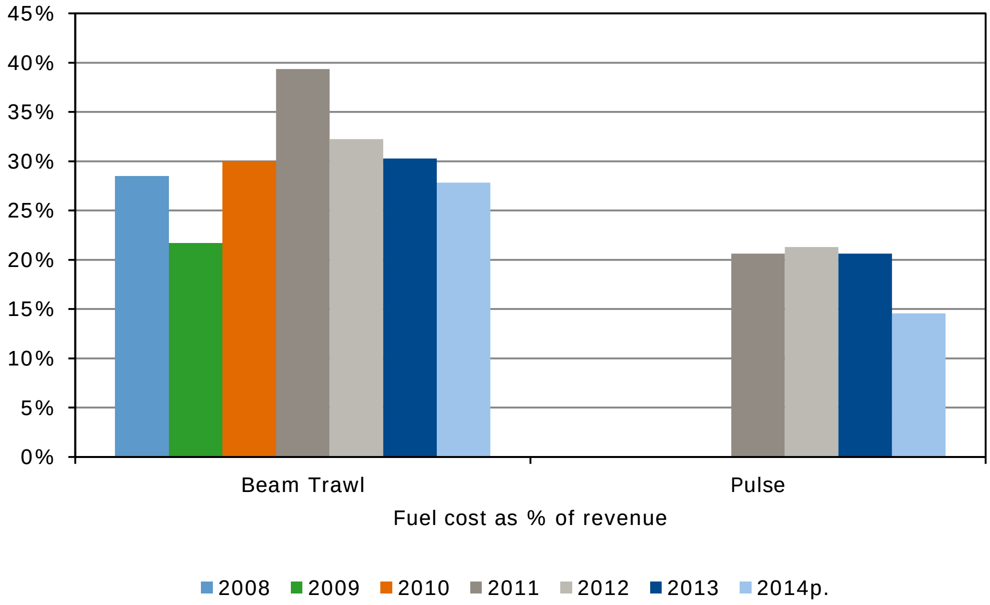

Figure 2.11 *Fuel costs as a percentage of the gross landings value in Dutch <=300 hp beam trawl, SumWing and pulse fisheries, 2008-2014. For reasons of privacy, the fuel costs as a percentage of the gross landings value have been combined for beam trawl fisheries for 2012, 2013 and 2014, and the same applies to pulse fisheries for 2011 and 2012*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Labour costs
The total labour costs for the Dutch active beam trawl, SumWing and pulse fisheries amounted to 34.5 million euros in 2014, 6% more than in 2013 (Figure 2.12). These labour costs consist of catch-based pay (89%), provisions (3%), social insurance (7%) and other duties payment (payments for extra work onshore: 1%). The distribution of the total labour costs among the different fisheries was as follows: pulse fisheries was responsible for a 29.8 million euro share of the costs and beam trawl and SumWing fisheries for 4.7 million euros.

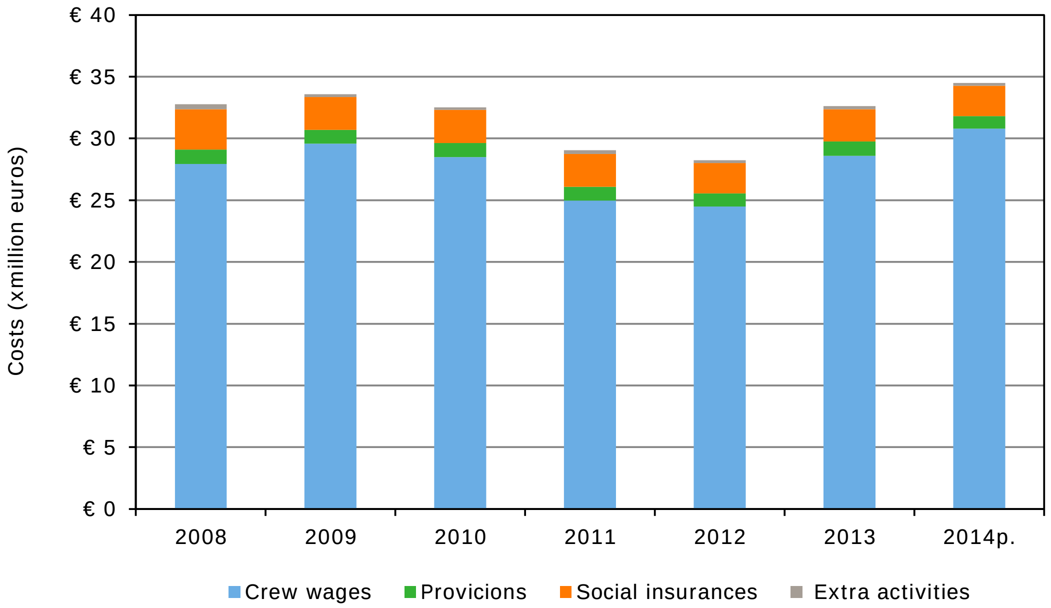

Figure 2.12 *Labour costs in Dutch beam trawl, SumWing and pulse fisheries, 2008-2014*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

In 2014, there were 709 crew members active in beam trawl, SumWing and pulse fisheries. In that year, the average costs per crew member amounted to around 48,700 euros (see Figure 2.13).

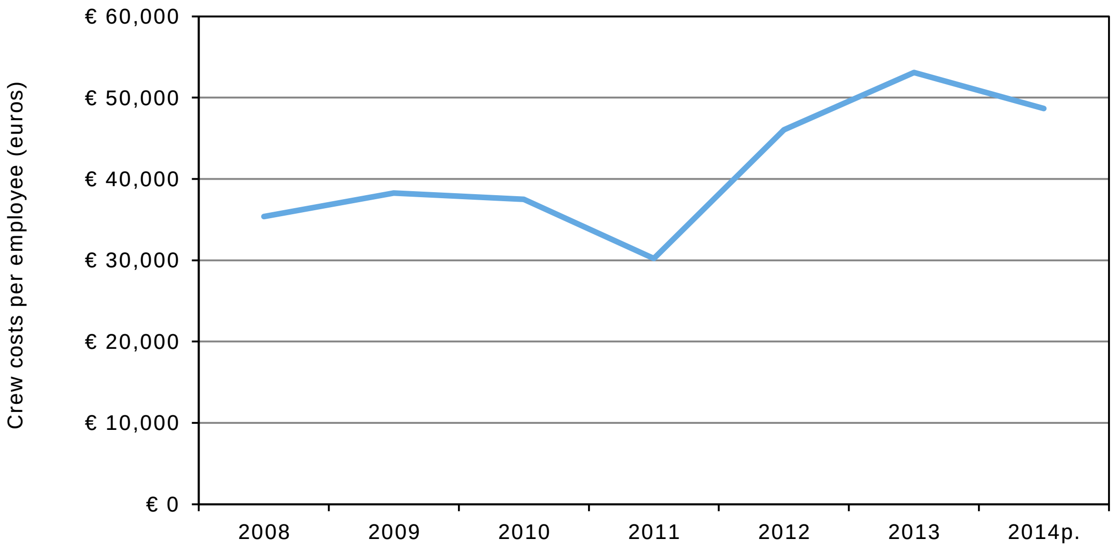

Figure 2.13 *Labour costs per crew member in Dutch beam trawl, SumWing and pulse fisheries, 2008-2014*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

In pulse fisheries, the costs per crew member were higher than average, at 54,700 euros per crew member (62,100 euros in pulse fisheries >300 hp and 38,600 euros in pulse fisheries <=300 hp). This difference is attributable to the fact that in pulse fisheries, the revenues per day at sea are often equal to or higher than in beam trawl or SumWing fisheries (see also Section 2.3.2). Furthermore, the other costs (excluding crew) are also often lower. This means that compared with beam trawl and SumWing fisheries, a relatively larger amount of the revenue remains to be divided among the crew (catch-based pay). As fuel costs decreased further after 2014, the average catch-based pay per crew member is expected to increase further in 2015 (and thus also the costs per crew member).

Catch-based pay

The catch-based pay paid to the crew members depends partly on the revenues that a cutter makes. After deducting the main cost factors (fuel costs, auction costs, technical costs, provisions and other matters that depend on agreements with the crew), an amount of the revenue remains that is divided among the crew members. A percentage share is agreed with each crew member that depends on their level of training, experience, tasks and position on board. In general, this share amounts to 40% to 42% for large cutters (>1,000 hp) and 45% for small cutters (<=300 hp).

Example of how pay is calculated:
In 2014, a fisherman who made all trips on an average >300 hp pulse cutter (185 days at sea with five crew members on average) received around 86,000 euros in wages, whereas a fisherman on a >300 hp beam trawl/SumWing cutter with the same number of crew members and days at sea received an average of around 56,000 euros. When compared to working on a beam trawler, a higher catch-based pay and relatively fewer working hours (as there is generally less fish to be processed on board) have ensured that working on a pulse cutter is an attractive option for a fisherman receiving catch-based pay.

Other costs
Other costs include quote leases, technical costs (maintenance costs, refrigeration and ice costs, vessel supplies), insurance costs, depreciations and interest, auction costs and other costs such as travel allowances.

Quote leases
A large part of the 'other costs' is taken up by costs for leasing quotas. When fishing entrepreneurs have little or no quota for sole themselves, they can lease this from others. Lease prices for sole quotas have risen considerably in recent years and therefore constitute a relatively high cost item. On the one hand, this is due to the higher demand for sole quotas from fishing entrepreneurs who have switched from beam trawl fisheries to pulse fisheries (the pulse technique has a higher catchability rate for sole than the beam trawl technique) and, on the other hand, to the availability of a relatively low quota for sole (9,281 tonnes in 2015). These two factors ensured that, between the first quarter of 2012 and the last quarter of 2015, the average lease price for sole rose from 0.60 euros to 3.38 euros per kilogram, an increase of 556% (Figure 2.14).

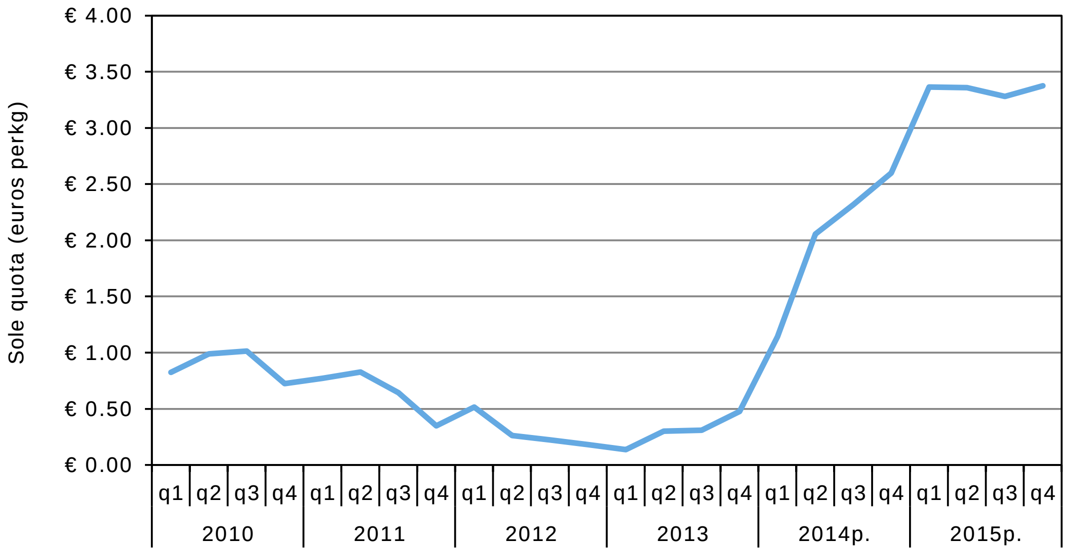

Figure 2.14 *Average lease price for sole quota, 2010-2015*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Investment in pulse trawling gear
To be able to catch fish using the pulse technique, cutters have to be equipped accordingly. The pulse system needs to be installed and new gear must be purchased. In recent years, the average investment for pulse gear on a large flatfish cutter was around 340,000 to 350,000 euros. For a small cutter (<=300 hp), the investment was somewhat lower, around 225,000 to 235,000 euros.

2.3.2 Revenues

The total revenues in the Dutch active cutter sector amounted to 239 million euros in 2014. The beam trawl, SumWing and pulse fisheries made up 55% of the total revenues with 131 million euros. In 2013, the revenues from these fisheries were 5% higher at around 138 million euros (Figure 2.15).

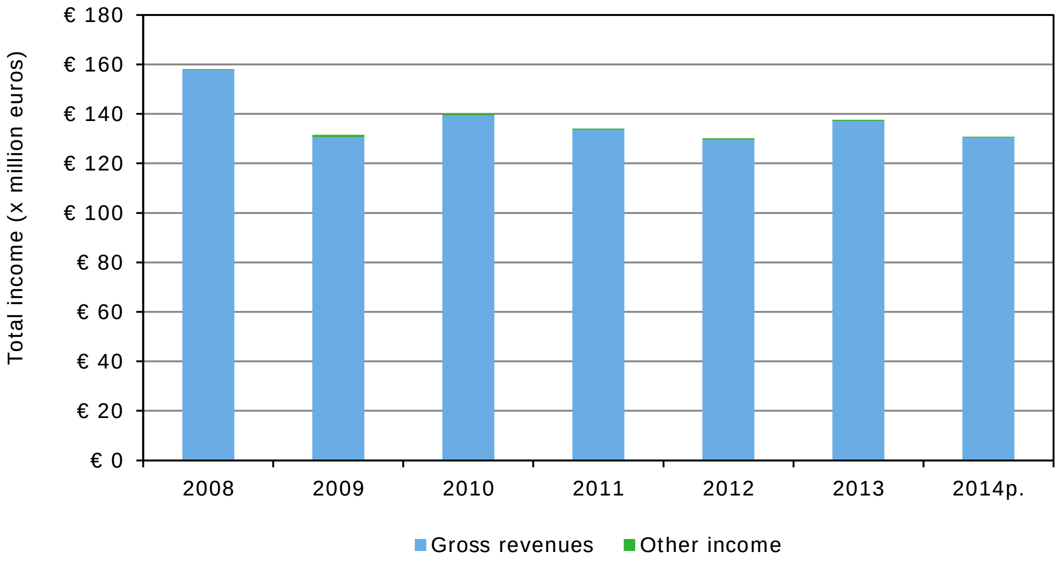

Figure 2.15 *Total revenues in Dutch beam, SumWing and pulse fisheries, 2008-2014*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

More than 99% of the revenues are determined by the gross landings value. Other income (<1%) is obtained from revenues that are not made from the sale of caught fish, such as participation in research, subsidies that are received or work for the offshore industry.

Gross landings value

The gross landings value for the Dutch beam trawl, SumWing and pulse fisheries are largely determined by the landings and prices of sole and plaice. Between 2009 and 2014, average plaice prices (in euros per kg of landing weight) were below 1.40 euros, with the lowest average value of 1.24 euros in 2013 (Figure 2.16). Prices rose again after 2013 to an average of 1.51 euros in 2015. Sole prices showed a decreasing trend between 2010 and 2013, from an average of 11.74 euros per kg to an average of 8.22 euros per kg of sole (landing weight). Prices for sole also increased from 2013 onwards, reaching an average value of 10.82 euros per kg in 2015.

Figure 2.16 *Average landing price for sole and plaice for the Dutch cutter fleet, 2008-2015*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

This study does not examine the possible effect of pulse fisheries on the landing prices of plaice and sole. The landings of plaice and sole by the active beam trawl, SumWing and pulse fisheries are shown in Figure 2.17. The quantity of landed plaice has been fluctuating since 2010 between 23.6 million kg (2014) and 28.4 million kg (2013) of live weight. In 2015, 26.2 million kg of plaice was landed, which is 11% higher than the year before. During the same period, the quantity of landed sole fluctuated between 7.7 million kg (2011) and 9.6 million kg (2013) of live weight. In 2015, the quantity of sole landed remained the same as in 2014.

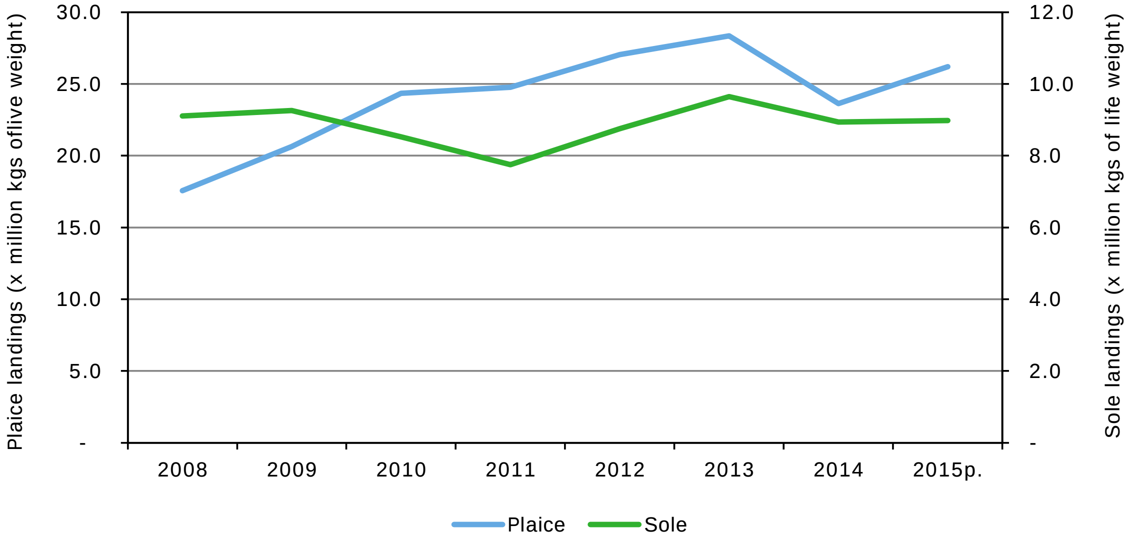

Figure 2.17 *Average landing quantities (live weight) of sole and plaice by the Dutch cutter fleet, 2008-2015*
Source: VIRIS.

2.3.3 Net result

The relatively low costs (112 million euros) and high revenues (131 million euros) produced a net result of around 19 million euros for the Dutch active beam trawl, SumWing and pulse fisheries. The fisheries using pulse technique in particular has made a significant contribution to this positive result.

Figure 2.18 shows that pulse fisheries generated a net profit of 17 million euros in 2014; a 271% increase compared to the year before. Of this, 81% (14.5 million euros) is attributable to the large pulse cutters. Despite the decrease in landings of the main fish species sole and plaice, the decrease in the average fuel price and the increase in fish prices for plaice and sole have led to this significant increase in profit. The further decrease in fuel price and further increase in fish prices and catches for sole and plaice in 2015 are expected to bring about a further increase in the net result for pulse fisheries to around 30 million euros.

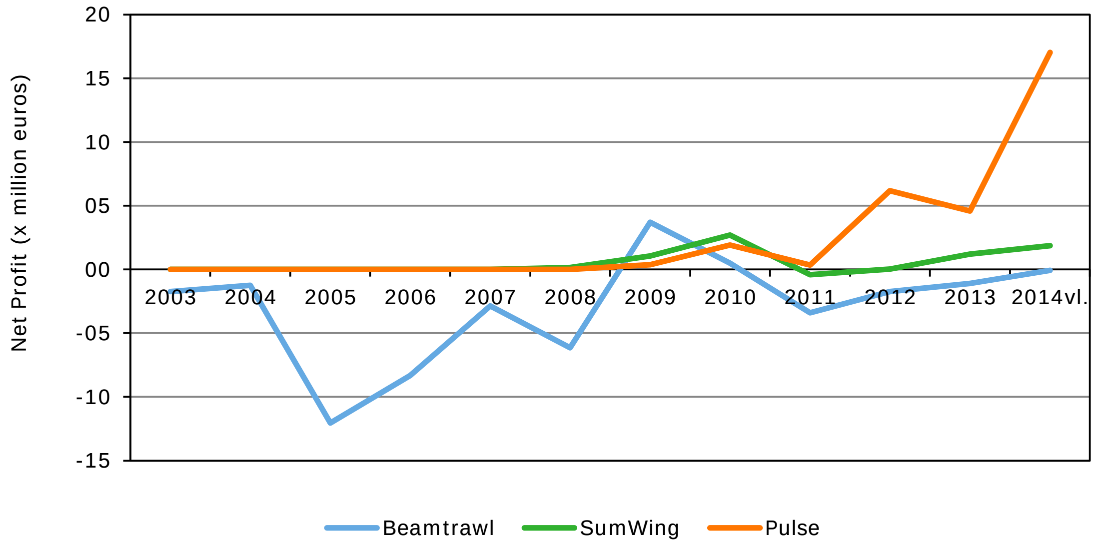

Figure 2.18 *Net result for Dutch beam trawl, SumWing and pulse fisheries, 2003-2014*
Source: Wageningen Economic Research's Fisheries Accountancy Data Network.

Beam trawl fisheries and SumWing fisheries show a result of 0 million euros and 2 million euros respectively. Beam trawl fisheries (and to a lesser extent SumWing fisheries) is highly dependent upon fuel prices because of their relative high levels of fuel consumption. On average, this fishing technique has not been profitable since 2003. Since its introduction in 2009, SumWing fisheries has shown a slightly positive result. In 2015, due to the decrease in fuel costs, the rise in the prices for plaice and sole, and the increase in landings, the joint result for beam trawl fisheries and SumWing fisheries was also positive, at around five million euros.

3 Geographical change in effort distribution flatfish sector

3.1 Method

For a number of subsets of the Dutch fishing industry, we looked at the change in effort distribution between 2008-2009 (pre-pulse fisheries period) and 2014-2015 (period with pulse fisheries) for different groups of trips:

1. All trips during which flatfish was caught (total)
2. Trips of 1- operated by vessels which switched to pulse between 2009 and 2015 (pulse vessel)

The change in effort distribution is calculated as an anomaly[1] for which the reference is 2008-2009. As the total effort has decreased since 2008 (Figure 2.1), effort is expressed per 3 x 3 nm square *k* as a percentage of the total effort for the period for the trip group *i*.

$$anom_{k,i} = \frac{\left(E_{k,i}^{2008} + E_{k,i}^{2009}\right)}{\sum_k E_{k,i}^{2008} + E_{k,i}^{2009}} - \frac{\left(E_{k,i}^{2014} + E_{k,i}^{2015}\right)}{\sum_k E_{k,i}^{2014} + E_{k,i}^{2015}}$$

The effort per 3 x 3 nm square was estimated using VMS and logbook data in accordance with the method developed by Hintzen et al. (2013).

Similarly, an anomaly was calculated for the landings of sole, to estimate where the landings came from and which areas were important for sole in particular.

A negative anomaly means that there is proportionally less effort/landings in the square in 2014-2015 compared to 2008-2009, while a positive anomaly reveals an increase in the effort/landings concentration in the square *k*. For example, an effort anomaly of +0.2% in a trip group with 10,000 days at sea annually means an extra 20 days at sea per year were spent in the square.

3.2 Effort

Figure 3.1 compares the change in effort distribution for flatfish trips (trips in which sole and plaice are caught) in the period 2014-2015 with the effort in the period 2008-2009 (as a percentage of the total). In most of the North Sea effort distribution did not change significantly (light blue and light red areas). We observe some areas showing a strong reduction of effort distribution (dark blue areas). The figure also shows several ‘hotbeds’ where the proportion of effort has increased considerably (red shaded areas in the figure), particularly in the southern part of the North Sea. In the following paragraphs we will focus on these areas.

[1] An anomaly is the deviation in a quantity from its expected value.

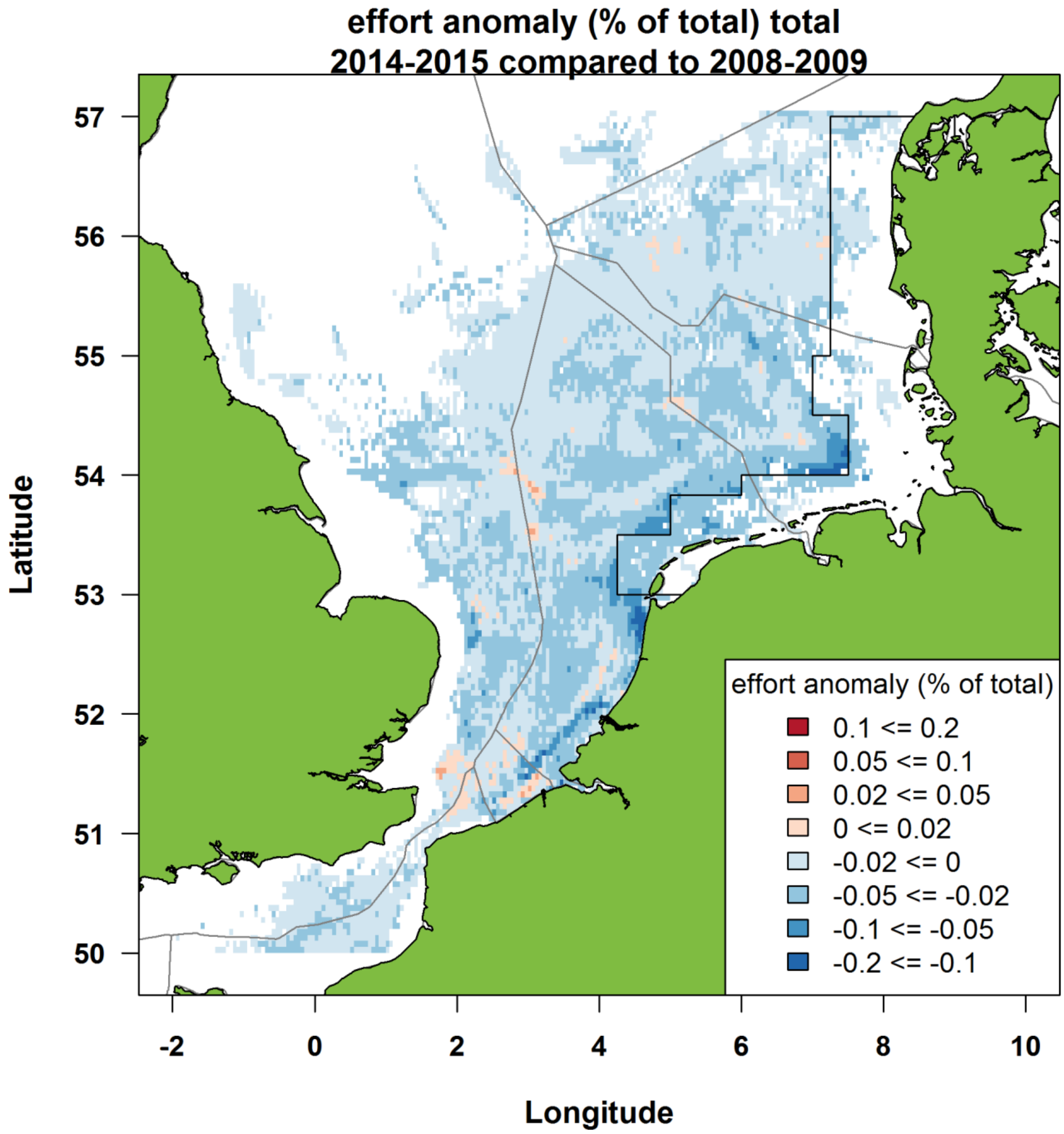

Figure 3.1 *Effort anomaly for Dutch trips with flatfish catches in 2014/2015 compared to 2008/2009 in percentages*
Source: VMS.

Figure 3.2 shows the same map but now only with cutters that had a pulse licence in 2014/2015. This figure shows the various hotbeds from Figure 2.4 more clearly. This confirms that it was the introduction of pulse fisheries in particular that brought about these changes in effort distribution. Fishing with Pulse technique makes it possible to fish in areas (particularly 'slushy' mud grounds) that could not previously be reached with the beam trawl or SumWing equipment. Below are descriptions of the main areas where efforts have increased due to fishing with pulse gear:

Smith's Knoll
Compared to the period 2008-2009, there has been a change in effort distribution towards the Smith's Knoll area of UK waters at the same height as IJmuiden. The Smith's Knoll area is known for being a location where it is easy to catch sole. Between April and October, the catches in this area are commercially viable. Outside this period, fishing efforts in the Smith's Knoll area shift more towards the south-western North Sea.

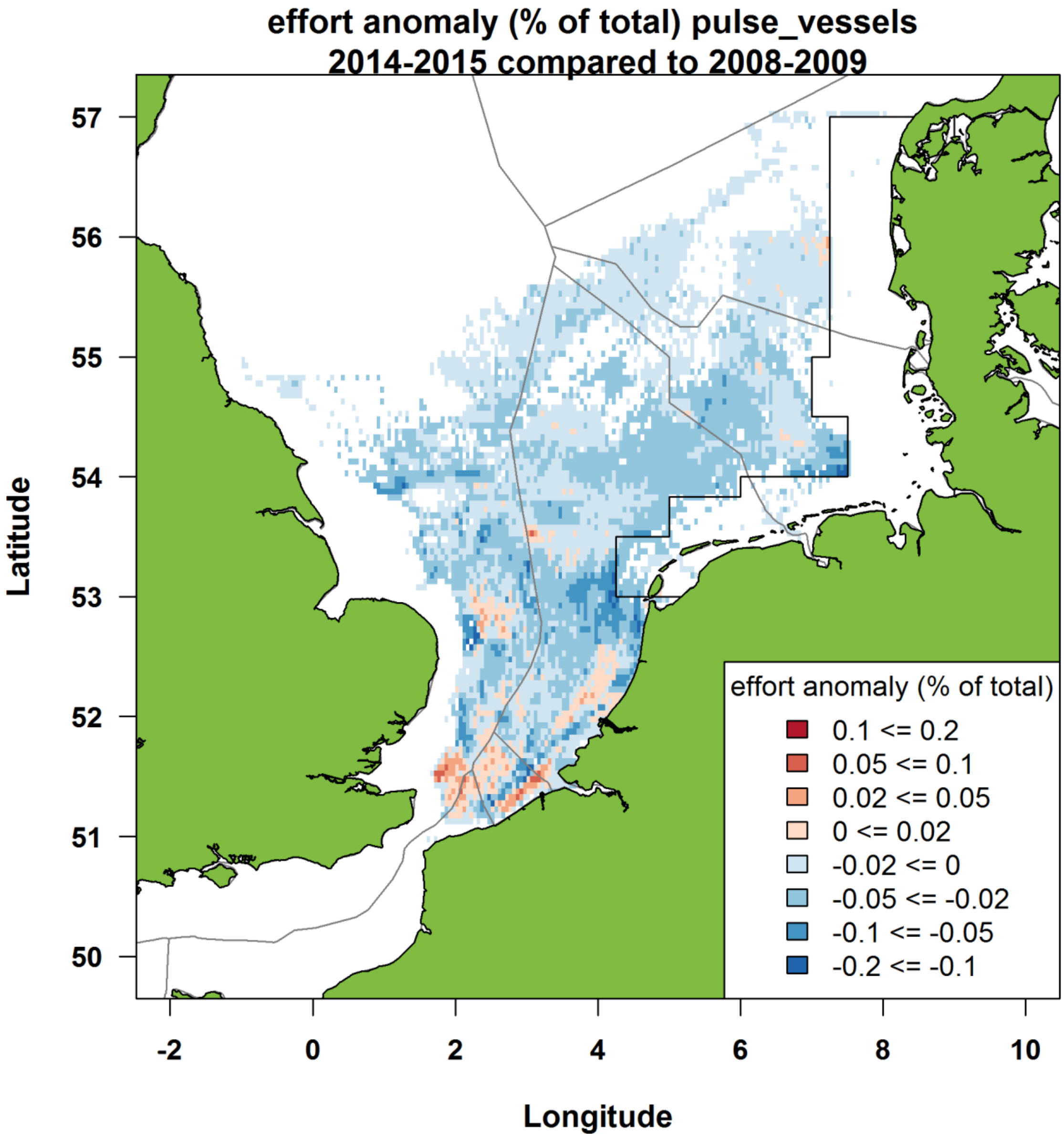

Figure 3.2 *Effort anomaly for Dutch pulse fleet in 2014/2015 compared to 2008/2009 in percentages Source: VMS.*

South-western North Sea (below 52 degrees latitude)
In addition to the ships from the Smith's Knoll area that mainly focus on the south-western North Sea during the period from November to March, this is also an area where pulse vessels from Zeeland are active. The introduction of the new flat fish gear has ensured for this group that in addition to fishing in its own spaces, it can also fish further west (again in softer grounds where beam trawl and SumWing gears could not previously be used for fishing). This is the area between the Foreland grounds and the South Falls (near to the Thames).

Belgian and Dutch coasts
The introduction of pulse fishing within the Eurocutter fleet (<=300 hp) has resulted in increased efforts off the Belgian coast where there is a high catchability rate for sole. Pulse cutters are also becoming increasingly active in the Dutch coastal area between Rotterdam and Katwijk.

Due to the good landing values in pulse fishing, the <=300 hp cutters are less and less likely to switch to shrimp fishing, which further increases fishing efforts using the pulse method. Eurocutters from the southern harbours are particularly active off the Belgian coast.

Appendix 1 contains anomaly maps for the catches of sole.

4 Conclusion and discussions

Thanks in part to the transition from conventional beam trawl fisheries to pulse fisheries, the Dutch cutter sector has been able to make its net results profitable once more over the last few years. The switch from conventional beam trawl fisheries to pulse fisheries requires an investment of around €230,000 for a <=300 hp cutter and an investment of around €350,000 for a large cutter (1,500-2,000 hp). The earn-back periods depend on the fuel and sole prices; however, with the price levels from 2013 to 2015, the earn-back period is less than two years for large cutters and around three years for <=300 hp cutters.

When compared to the conventional beam trawl technique, fuel consumption is significantly lower and, with it, also the CO_2 emissions. There are three reasons for this:

1. Pulse gear is lighter than beam trawl gear
2. There is less contact with the seabed
3. The vessels fish at lower speeds.

The use of pulse technique has therefore led to a substantial reduction in fuel consumption. For example, fuel consumption per day at sea for a >300 hp cutter involved in pulse fisheries is 46% lower than the same type of cutter involved in beam trawl fisheries; for a cutter fishing with SumWing technique, this percentage is 18%. For pulse cutters with an engine power of 300 hp or less, the difference with a beam trawl cutter in the same horse power class is 12%.

The higher yields have also resulted in considerably higher catch-based pay for crew members. Each crew member on a vessel that uses pulse technology earns considerably more per year than a crew member on a ship using conventional beam trawl technology. In 2014, this was approximately €30,000. On the one hand, this makes it easier for fisheries that use the pulse technique to keep hold of crew members and, on the other hand, the desire to retain crew members has resulted indirectly in fisheries making a quicker transition to pulse fisheries.

The pulse technique has a higher catchability rate for sole. As the fleet has largely switched to this technique, there has been an increase in demand for sole quotas. Many of the fishermen who have switched to this technique do not have enough sole quotas themselves and therefore lease additional quotas. Due to the increased demand for sole quotas, the lease price for sole quotas has risen from 60 eurocents per kilogram in 2012 to 3.38 euros in 2015. The higher lease price for sole also has consequences for other fisheries, such as gillnet fishing, which do not have a quota themselves and previously leased sole quotas.

The switch from beam trawl fisheries to pulse fisheries has led to a change in effort distribution in the areas where fishing takes place. The reason for this is that fishing grounds that were previously avoided are now accessible. This is because the tickler chains of the beam trawl gear can sink into the softer grounds of these areas or pull too much sand and clay along with them, while the light pulse gear glides over the seabed more easily. In addition, the greater focus on sole has led to relatively more fishing in areas where more sole can be caught. This entails a displacement from areas where the beam trawl method focuses more on catching plaice to areas where the pulse method focuses more on catching sole. Areas where more fishing takes place nowadays include the Smith's Knoll area of UK waters at the same latitude as IJmuiden, the areas between the Foreland grounds and South Falls (near to the Thames) and the Belgian and Dutch coastal areas between Rotterdam and Katwijk.

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Appendix 1 Maps showing change in distribution of sole catches

The geographical change in catch distribution due to alternative fishing gear in the flatfish sector also results in geographical changes of sole catches. Figure A1.1 shows the catch anomaly for sole from 2014 to 2015 as a comparison with the sole catches from 2008 to 2009 (as a percentage of the total).

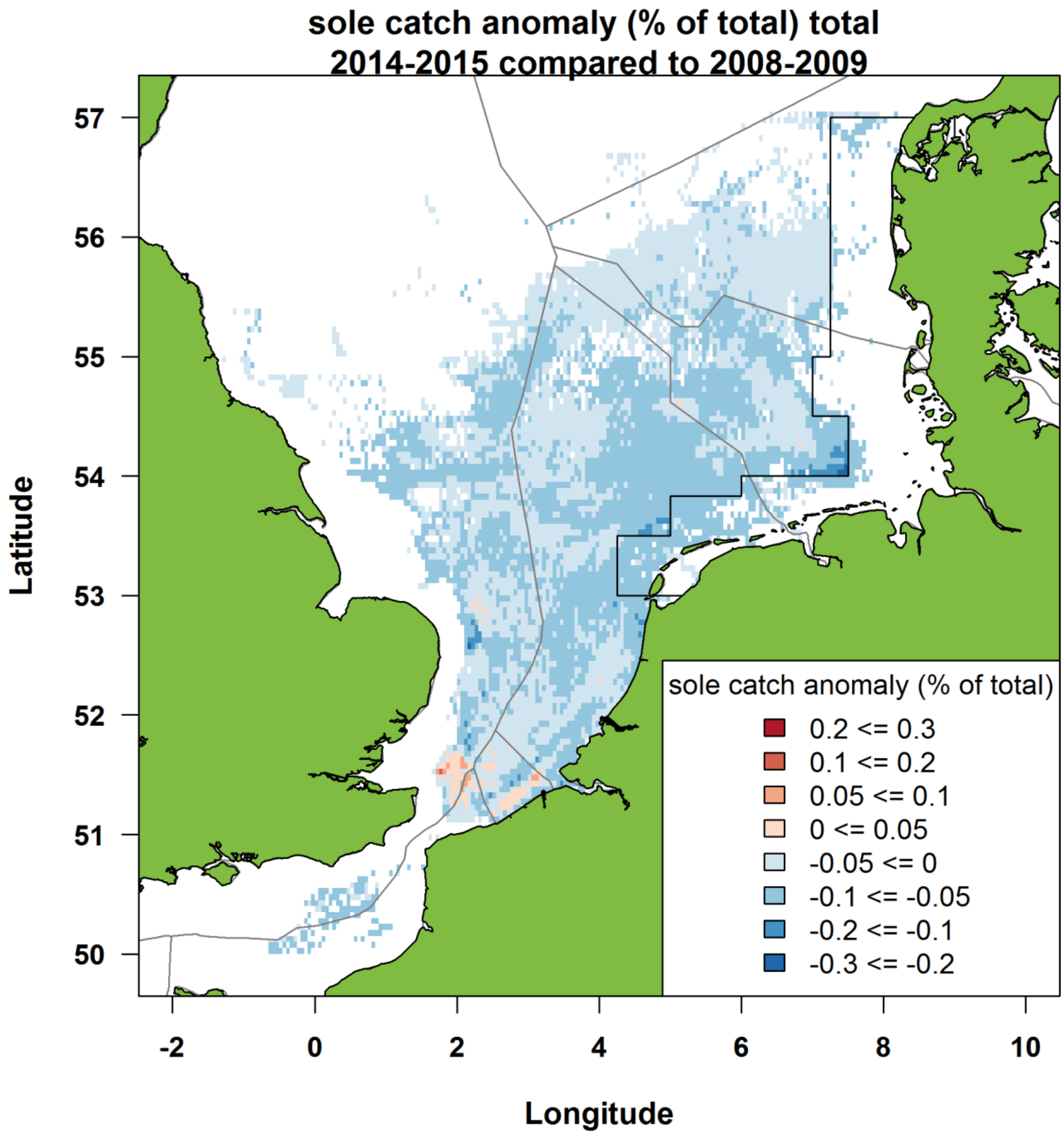

Figure A1.1 *Anomaly in sole catches for Dutch active cutter fleet, 2014/2015 compared to 2008/2009 in percentages*
Source: VMS.

Figure A1.2 shows the change in catch distribution for sole during the period from 2014 to 2015 for cutters that had a pulse licence in 2014/2015 as a comparison with the sole catches during the period from 2008 to 2009 (as a percentage of the total).

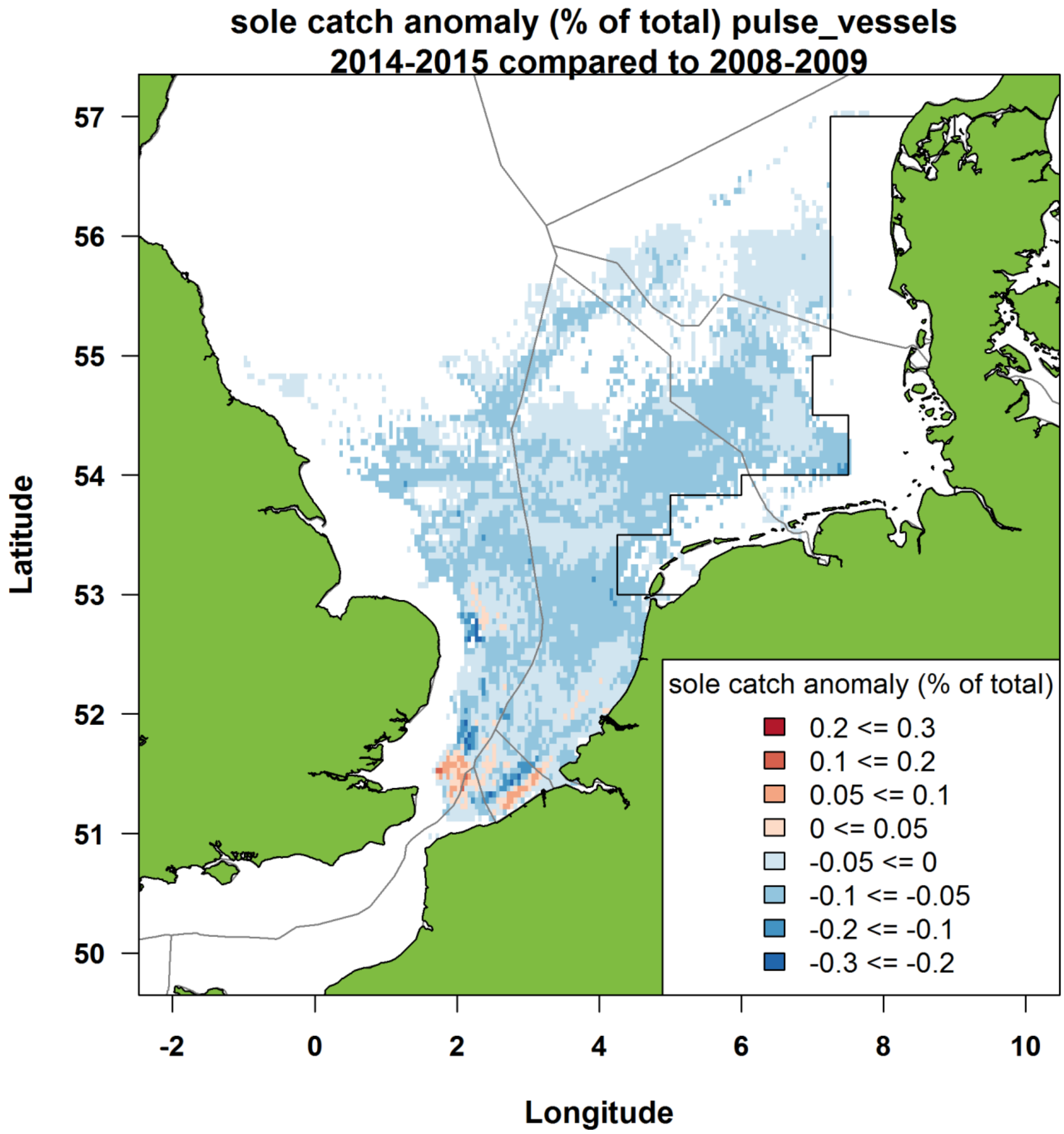

Figure A1.2 *Anomaly in sole catches for Dutch active pulse fleet, 2014/2015 compared to 2008/2009 in percentages*
Source: VMS.

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REPORT
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