



Cod monitoring

Results 2015, Quarter 3

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1. Introduction

The Cod monitoring program is part of the Dutch cod avoidance plan developed by the Dutch Government together with the Dutch fishing sector. The aim of this cod monitoring program is to provide information on the Catch per Unit Effort (CpUE) in the TR fleet (bottom trawls and seines). This is needed in order to calculate a conversion factor between the CpUE of the TR and the BT (beam trawl) gears. The transition of kW-days between gears is regulated by the European cod recovery plan (EC 423/2004 and EC 1342/2008) and depends on the yearly 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 (TR1AB¹) and those for which cod is bycatch (i.e. TR1C and TR2) (see table 1). The kW-days transition only applies to the second group, fisheries for which cod is bycatch. For the kW-days transition between the BT and the TR gears for which cod is bycatch (TR1C and TR2) a conversion factor of 3:1 is used in the Netherlands. This is different than stated in the European Cod Recovery Plan and therefore the ratio should be substantiated for.

Table 1. Definitions of the fleet segments used in this report.

Fleet definition	Gear type	Meshsize (mm)	Assumed target species
TR1AB	Otter/pair trawlers	>120	Cod
TR1C	Otter/pair trawlers	100-119	Plaice
TR2	Otter/pair trawlers	70-99	Plaice/Nephrops
BT2	Beam trawlers	70-119	Plaice/Sole

Between 2011 and 2013, the monitoring program existed of an extended analysis of self-reported cod catch data (both landings and discards) in combination with the regular DCF discard monitoring program, an extra observer program and the CCTV-project in TR-fisheries (see Kraan *et al.*, 2013 and 2014). Over the years, the ministry of Economic Affairs and IMARES drew the conclusion that monitoring cod discards via the self-reporting scheme asked for disproportionately high effort of the TR-skippers while discards were hardly affecting CpUE rates (Ministry of Economic Affairs, 2014). Therefore, it was agreed upon a yearly analysis of the EU-logbook (hereafter logbook) data in combination with VMS-data, which is readily available. However, to remain updated, an overview of fishing activity, cod catches and cod Landings per Unit Effort (LpUE) of all four gear types per quarter is requested by the ministry of Economic Affairs. This report presents the results of the third quarter in 2015.

As monthly maps of LpUE are used by the Marine Management Organisation (MMO) to determine Real Time Closures (RTC), we present the average monthly distribution of LpUE in 2014 and 2015 in appendix B for the months in quarter 3 (Figures B1, B2, B3). These figures are compatible with the data requirements for the MMO, and as such, may be used to forecast future RTC's.

¹ Some fishermen fishing with TR gear, 120+ mesh size are targeting plaice with cod as minor by-catch.

2. Materials and Methods

In this section, the data sources and the final output are described. See “Appendix A. Extended Material and Methods” for a detailed description of the method to link VMS and logbook data. The method used in this report is consistent with the method described in Hintzen *et al.* 2013.

2.1 Logbook data

All fishermen are obliged to report their activities on a daily basis. This includes location, gear used, vessel characteristics and estimated landing quantities (in kg). These quantities are an estimation and therefore deviate from auction data. Moreover, fishermen do not have to report catches for species with a trip-total quantity below 50 kg. As cod is a by-catch species, trips with cod landings lower than 50 kg can be expected. Therefore, the cod catches in this report are an (under)estimation of the total catches. Second, fishermen report all landings and vessel characteristics online and the data are immediately imported in the database of the Dutch Government. The logbook data cannot be validated or checked by IMARES on correctness of the data. Therefore, records with a type-error in the gear description will not be recognised as ‘wrong’, but will wrongly be taken into consideration.

2.2 VMS data

All ships over 12 meters are obliged to participate in the Vessel Monitoring System (VMS). This system sends an update to a satellite, containing time and date, position, speed and name of the vessel. All these records are registered by the Dutch government. IMARES has permission to work with these data.

2.3 Value maps

All value maps show data for quarter 3 of 2015, summed for all gears together and for all gears separately. To facilitate the visual comparison between quarterly and yearly spatial distribution, values of fishing activity and landings in quarter 3 are multiplied by 4. By doing so, fishing activity and landings per quarter have similar value ranges as yearly fishing activity and landings value ranges. To supply actual quarterly fishing activity and cod landings, each map includes a box underneath with the absolute quarterly value for that (those) gear(s).

2.4 Calculate LpUE ratio

A quarterly indicator of the conversion factor between the TR and the BT gears is given. This indicator is based on the ratio between LpUE of the TR gears for which cod is bycatch (TR1C and TR2) and the BT2 gears (see formula (1)). As this analysis is based on logbook data, in which cod landings are reported in kg (with a minimum of 50 kg), the calculated ratio in LpUE has a large uncertainty range not accounted for in this quarterly report. A more detailed yearly ratio in LpUE between BT and TR will be given in the extensive year report, that will be published later this year.

$$(1) \quad \left(\frac{(\text{Cod landings TR1C+TR2})}{(\text{Fishing activity TR1C+TR2})} \right) / \left(\frac{(\text{Cod landings BT2})}{(\text{Fishing activity BT2})} \right)$$

3. Results

3.1 Fishing activity

Fishing activity was calculated for all gears together (figure 1) and for each gear separately (figure 2) (table 2). Fishing activity is displayed in kW-days, which represents days at sea multiplied with the engines power, as the day-transition is applied to kW-days. Most fisheries are concentrated in the southern North Sea with a band of higher intensity also stretching across the central North Sea and at the Doggersbank.

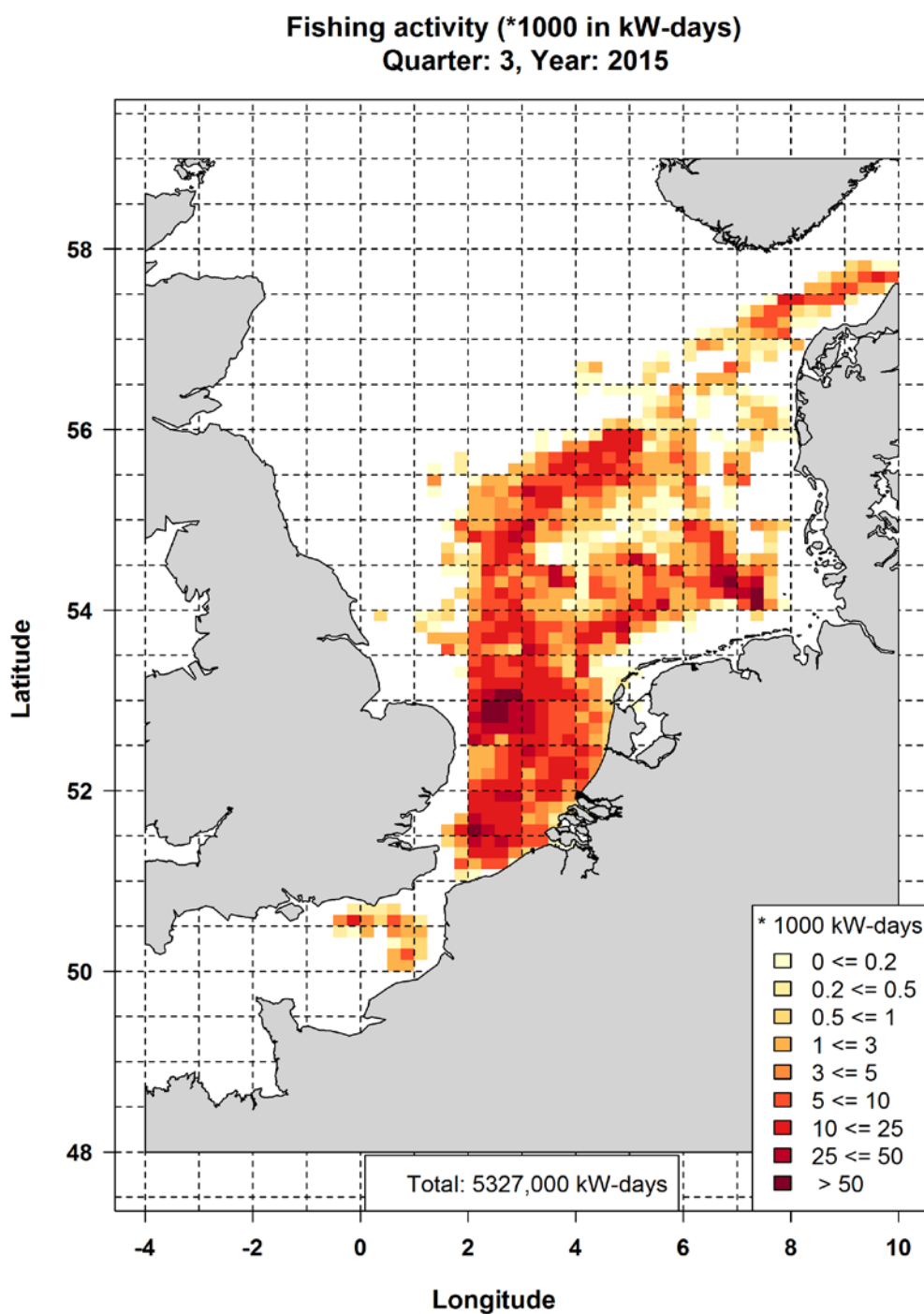


Figure 1. Fishing activity (in *1000 kW-days) for all TR and BT2 gears together in quarter 3 in 2015. The box underneath the map shows the total fishing activity for all gears combined in this quarter.

Fishing activity is dominated by BT2 gears, with only a small contribution of TR gears (figure 2, table 2). The TR2 fleet is the most active fleet within all TR gears, with an effort of 383'000 kW-days. This fleet is active in the English Channel, but also concentrated at a number of known Nephrops (*Nephrops norvegicus*) fishing grounds, such as the Botney gut/Silver pit, the Oystergrounds and east off Horns Reef (ICES, 2014). Whilst the activity of BT2 gears is slightly less compared to the first 2 quarters of this year (Reijden *et al.*, 2015a; Teal *et al.*, 2015) the TR1AB fleet is considerably more active in quarter 3.

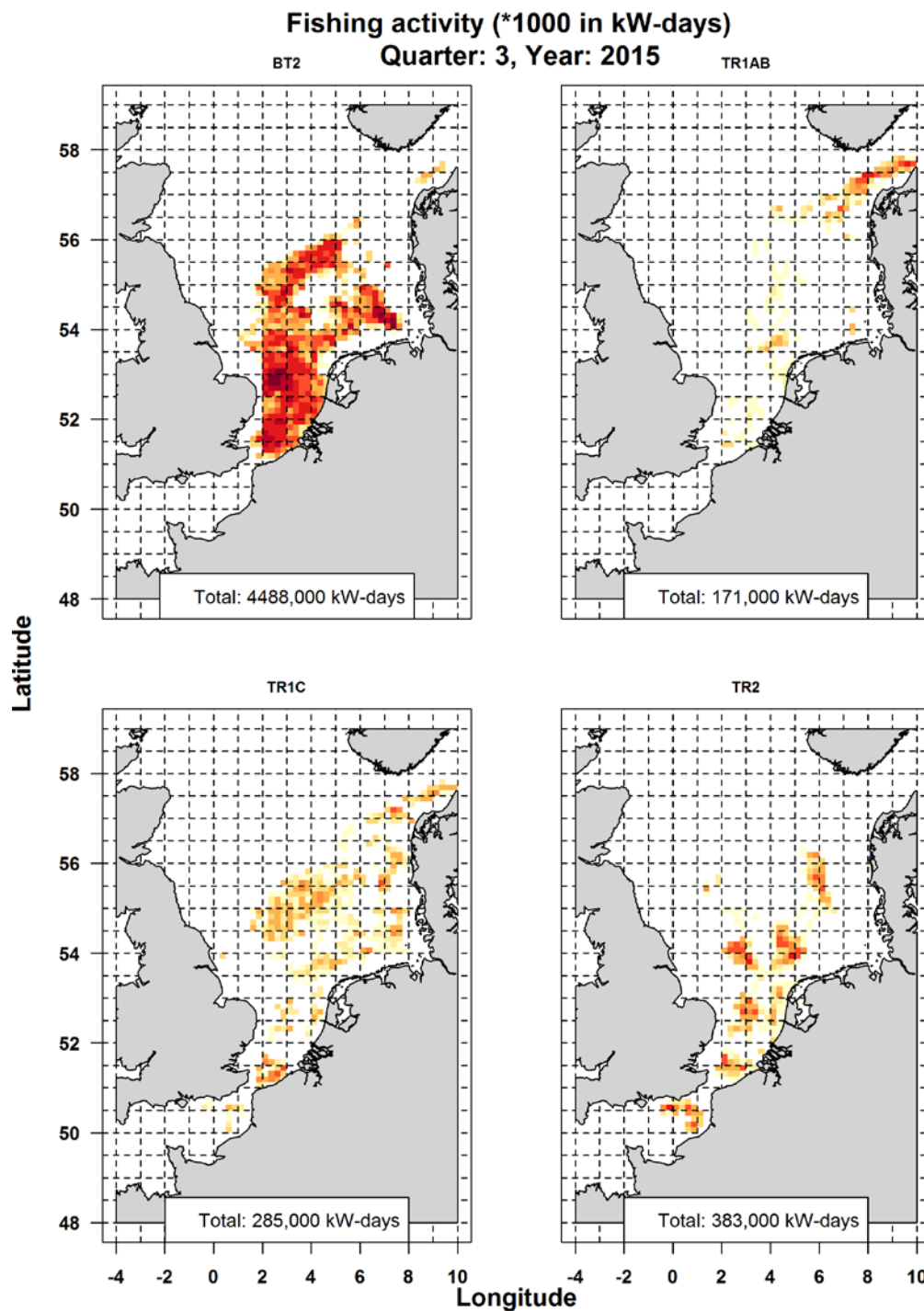


Figure 2. Fishing activity (in kW-days/1000) for the BT2, TR1AB, TR1C and TR2 gear types separately. Colour index is similar to figure 1. The box underneath each map shows the total fishing activity (in kW-days) per gear for this quarter.

3.2 Cod landings

Most landed cod was caught at the entrance of the Skagerrak and in the South off the Belgian Coast. Total landings are much higher compared to quarter 1 and quarter 2 (Reijden *et al.*, 2015a, Teal *et al.*, 2015).

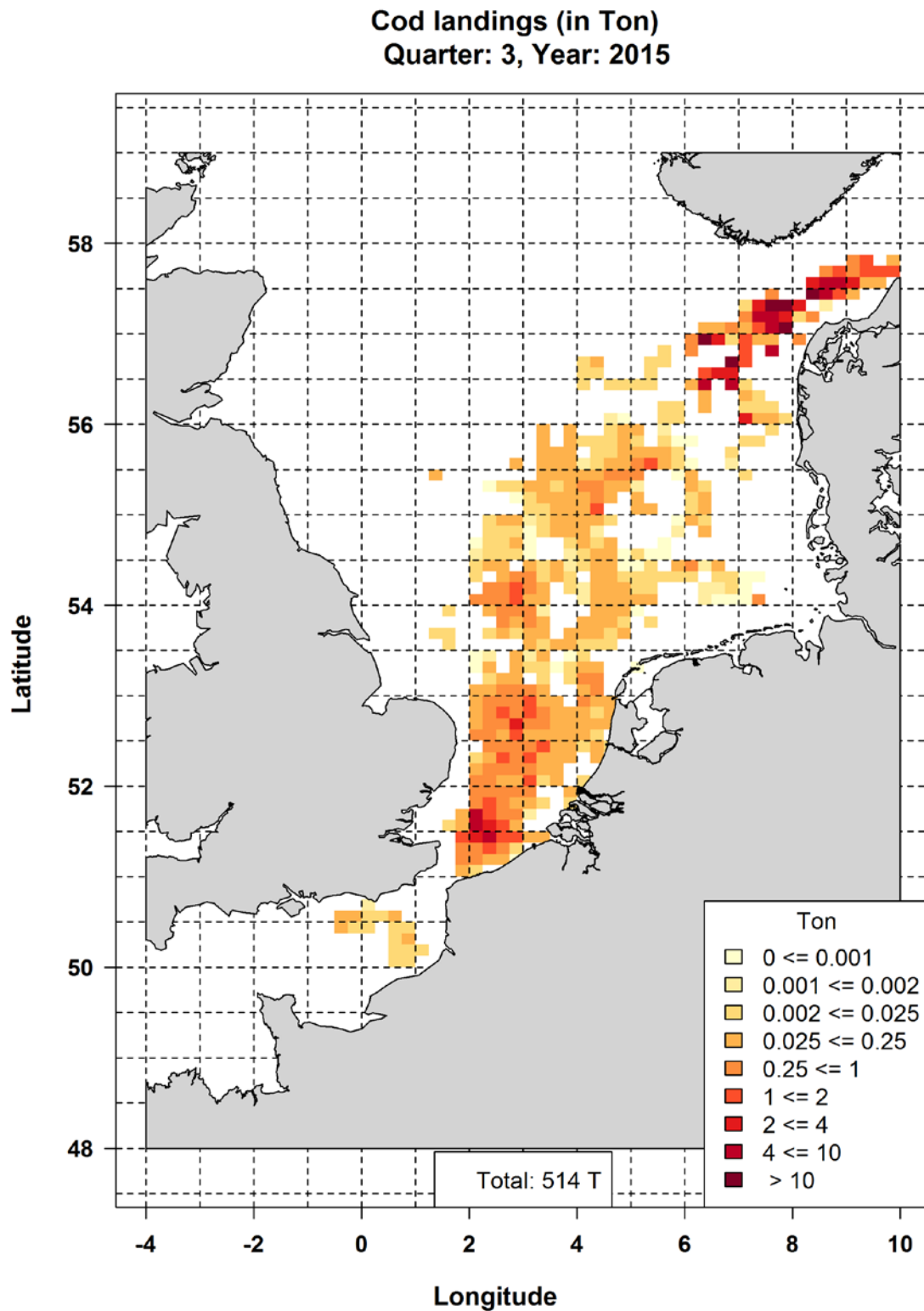


Figure 3. Cod landings (in Ton) for all TR and BT2 gears together in quarter 3 in 2015. The box underneath the map shows the total cod landings for all gears combined in this quarter.

In the third quarter, landed cod was almost exclusively caught by TR1AB gears (figure 4, table 2). This fleet is responsible for the hotspot of landings originating from the opening of the Skagerrak. The high catches observed in the southern North Sea are mainly caught by the TR2 and to a lesser extend by the BT2 fleet.

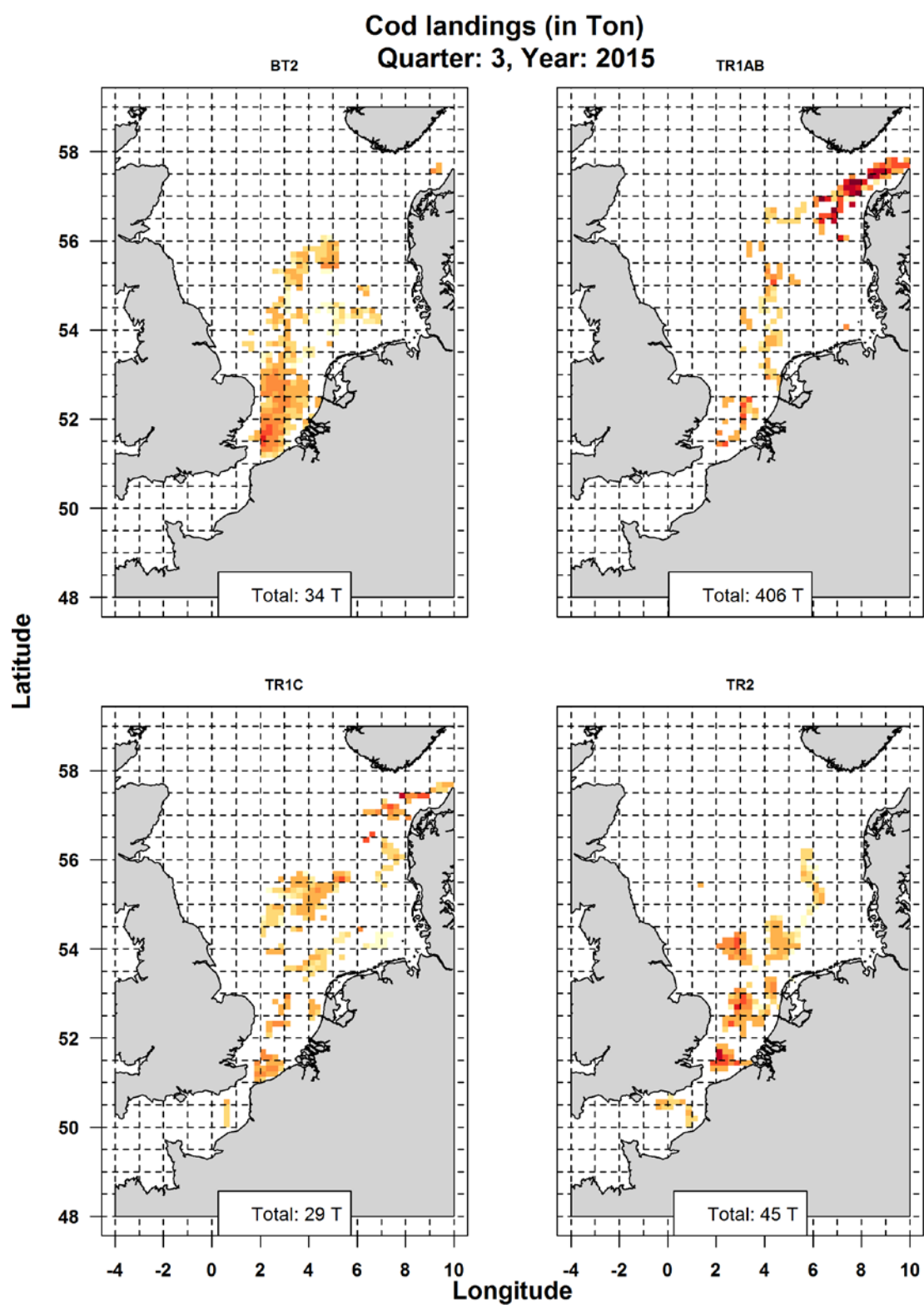


Figure 4. Cod landings (in Ton) for the BT2, TR1AB, TR1C and TR2 gear types separately. Colour index is similar to figure 3. The box underneath each map shows the total cod landings (in Ton) per gear for this quarter.

3.3 Cod LpUE

The cod landings per unit effort (LpUE) can be calculated for each 1/16th ICES rectangle by dividing the cod catch (in kg) by the fishing effort (in kW-days) (figure 5). Highest LpUE are shown around the entrance to the Skagerrak.

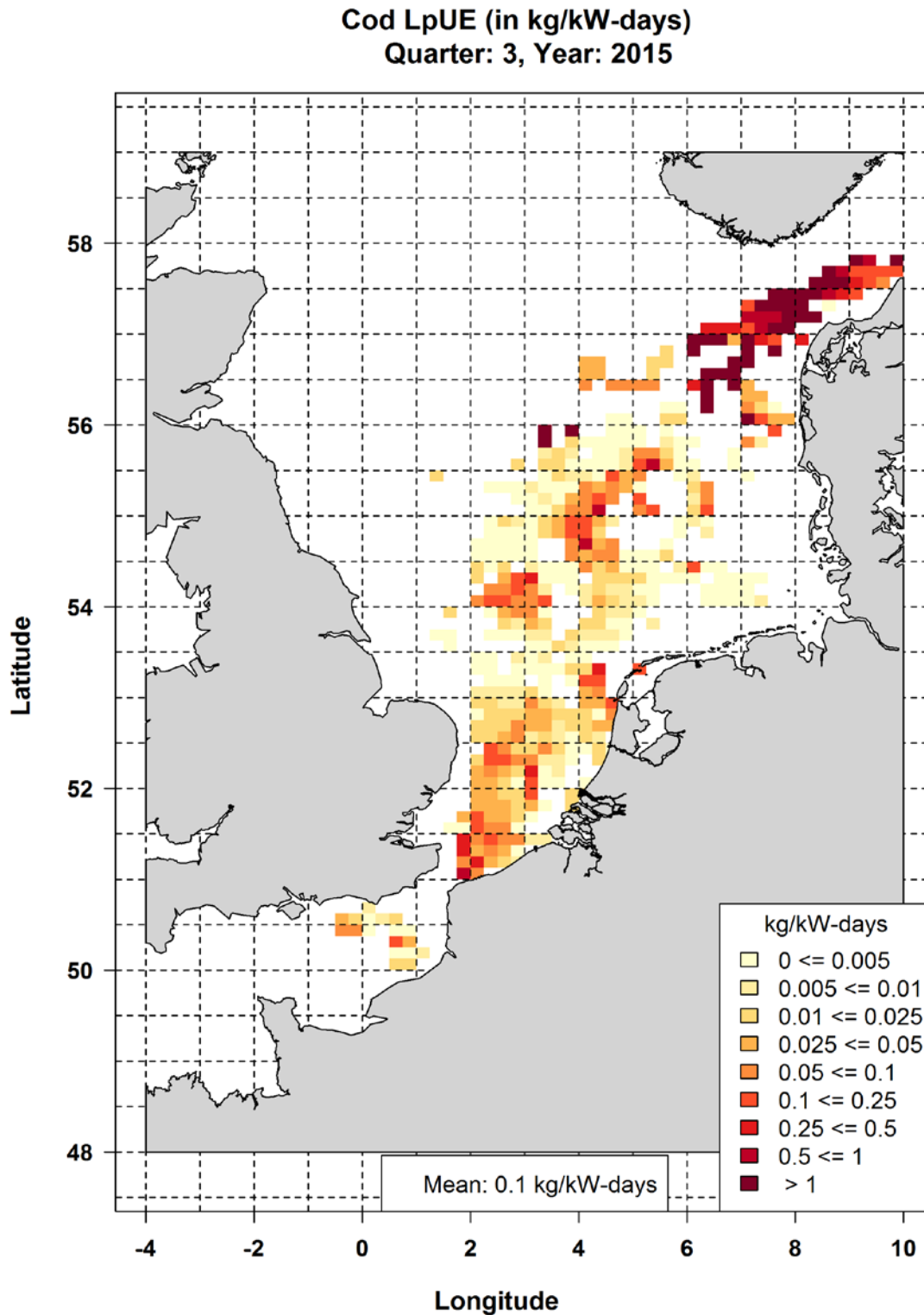


Figure 5. Cod LpUE (in kg/kW-days) for all TR and BT2 gears together in quarter 3 in 2015. The box underneath the map shows the total LpUE for all gears combined in this quarter.

The TR1AB gear had the highest cod LpUE on average (2.37 kg/kW-days) (figure 6, table 2) and high LpUE at almost all areas where fishing was recorded. The LpUE of the BT2 gears was very low despite having by far the highest fishing activity (figure 2, table 2). The TR1C shows highest LpUE at the entrance of the Skagerrak. In the southern North Sea, the TR1C gears show increased LpUE as well. The TR2 gear shows highest LpUE in the Botney gut/Silver pit and spreading down to southern North Sea.

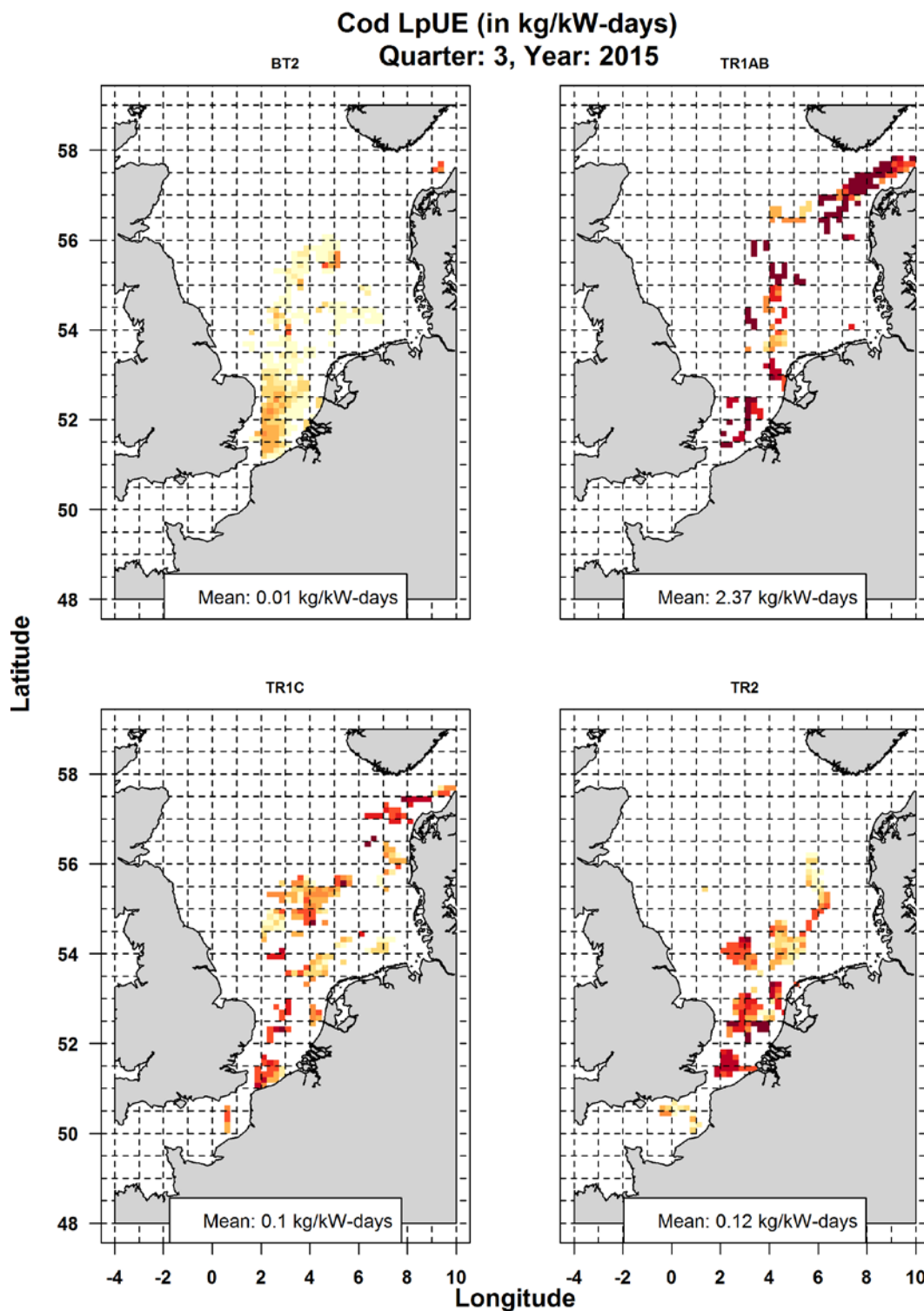


Figure 6. Cod LpUE (in kg/kW-days) for the BT2, TR1AB, TR1C and TR2 gear types separately. Colour index is similar to figure 5. The box underneath each map shows the total LpUE (in kg per kW-days) per gear for this quarter.

4. Summary

In quarter 3 the fishing effort of the fleet is dominated by the BT2 fleet with 84% of the total fishing activity. This fleet is located widespread over the central-east and southern North Sea (figure 2), most likely targeting plaice and sole in these areas. The fishing activity of the TR fleet is much lower, with the TR1AB fleet showing the lowest activity (3% of total fishing activity, table 2) and the TR2 fleet showing the highest activity (7% of total fishing activity, table 2). Despite the differences in quarterly fleet fishing effort, a similar pattern is observed for all three quarters in 2015 (effort TR1AB < effort TR1C < effort TR2; Teal *et al.*, 2015, Reijden *et al.*, 2015a). When compared with quarter 2 2015, the spatial distribution of the fishing effort of the TR fleets has changed. TR1AB is concentrated at the entrance of the Skagerrak, whilst in quarter 2, almost no activity was observed in this area (Teal *et al.*, 2015). The TR1C fleet is more scattered over the North Sea, with more fishing in the opening of the Skagerrak and near the Belgian Coast. The spatial distribution of the TR2 fleet has little changed, but activity in the English Channel has decreased whilst other fishing grounds have remained similar (Teal *et al.*, 2015).

Total cod landings (figure 3) are more than double the landings recorded in quarter 2 in 2015 (514T and 246T respectively) and also more than the landings recorded in quarter 3 in 2014 (374T; Teal *et al.*, 2015, Reijden *et al.*, 2015b). This can mainly be attributed to the considerably higher landings of the TR1AB fleet (60T in 2015 Q2 and 263T in 2014 Q3 compared to 406T in 2015 Q3). The increase of cod landings in the TR1AB fleet can partly be explained by the increase in fishing effort of this fleet (54.000 kWdays in 2015 Q2 compared to 171.000 kWdays in 2015 Q3). However, spatial distribution of the fishing effort also influenced the high cod landings, with in quarter 3 more fishing effort at the opening of the Skagerrak than in quarter 2 of 2015. Especially at that location, the TR1AB shows high cod landings (figure 4, figure 6). Compared with Q3 in 2014, the increase in fishing effort is less (148.000 kWdays in 2014 Q3) and the differences in spatial distribution are less obvious as well (Reijden *et al.*, 2015b). This may suggest that cod abundance has increased at the entrance of the Skagerrak compared with Q3 2014.

Due to the high cod catches of the TR1AB fleet, the overall LpUE has increased drastically to an average of 0.10 kg/kWdays for quarter 3. For quarter 1 and 2 of this year, an average of around 0.05-0.06 kg/KW days was found (Teal *et al.*, 2015; Reijden *et al.*, 2015a). When only considering the other fleet segments (BT2, TR1C, TR2), total cod LpUE have decreased, due to a decrease in TR2 and BT2 LpUE. In quarter 2, the LpUE for the TR2 fleet was high in the central North Sea, but also near Off Horns Reef and in the English Channel (Teal *et al.*, 2015). This report shows that LpUE for the TR2 fleet remained high in the central North Sea, but has decreased in the English Channel and near Off Horns Reef. Similar patterns can be observed for the BT2 fleet; unchanged LpUE in the central North Sea, and decreased LpUE at the outer regions.

For facilitating comparisons between quarters, the quarterly totals of fishing activity and cod landings and the quarterly average LpUE are shown in Table 2. If the kW-days transition was determined based on the LpUE in quarter 3, the conversion factor would be 14.6:1. This is lower than both the conversion factor calculated based on quarter 2 in 2015 (18:1; Teal *et al.*, 2015) and the conversion factor based on quarter 3 (21:1; Reijden *et al.*, 2015b) in 2014 but still higher than the currently used conversion factor of 5:1. However, as the conversion factor is determined on yearly LpUE, the calculated factor in this report is only an indicator. When taking quarters 1 and 2 of 2015 into account, the conversion factor would be 6.7:1, which is already closer to the currently used factor.

Table 2. A summary of fishing activity (% of total), cod landings (% of total) and average LpUE for the 4 gears separately and the overall total for quarter 3.

	Fishing activity (*1000 kW-days)		Cod Landings (Ton)		Average LpUE (kg per kW-days)
BT2	4488	(84.2%)	34	(6.6%)	0.00758
TR1AB	171	(3.2%)	406	(79.0%)	2.37427
TR1C	285	(5.4%)	29	(5.6%)	0.10175
TR2	383	(7.2%)	45	(8.8%)	0.11749
Total	5327		514		0.0965

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 C150/15
Project Number: 4308101082

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

Approved: Ralf van Hal
Researcher

Signature:



Date: 4th of November 2015

Approved: Nathalie Steins
Head of department Fisheries

Signature:



Date: 30th of October 2015

Appendix A. Extended Materials and Methods

Data pre-processing

VMS and logbook data were received from the Ministry of Economic Affairs and stored in a local database at IMARES.

VMS records are considered invalid and are therefore removed from the analyses if they :

- o Are duplicates or pseudo-duplicates (indication of malfunctioning of VMS device)
- o Identify an invalid geographical position
- o Are located in a harbour
- o Are located on land
- o Are associated with vessel speeds > 20 knots

Logbook records are removed from the analyses when they:

- o Are duplicates
- o Have arrival date-times before departure date-times
- o Overlap with other trips of that vessel

Link VMS and logbook data

VMS and logbook datasets are linked using the unique vessel identifier and date-time stamp in both datasets available. In other words, records in the VMS dataset that fall within the departure-arrival timeframe of a trip described in the logbook are assigned the unique trip number from the logbook record which allows matching both datasets. The following gear types were selected as TR gear: OTB (Otter bottom trawls), OTT (Otter Twin Trawls), PTB (Pair Bottom Trawls), SDN (Danish Seine), SSC (Scottish Seines), SPR (Pair Seine). All TR gears are further divided based on their mesh size, following TR1AB: $\geq 120\text{mm}$, TR1C: $100 - 119\text{mm}$, TR2: $< 100\text{mm}$. The BT gear is defined as TBB (Beam Trawls) gear type. This consists not only of the traditional beam trawl; all innovative sub-gears like sumwing, pulse and pulswing are included in the BT gear. Next, the BT gear is further classified into categories, based on mesh size. The used gear type BT2 includes all BT vessels operating with a mesh size of 70-99mm.

Define fishing activity

Speed recordings obtained from VMS data are used to create frequency plots of these speeds, where along the horizontal axis the speed in knots is given and the vertical axis denotes the number of times that speed was recorded. In general, 3 peaks can be distinguished in such a frequency plot. A peak near 0 knots, associated with harbour/floating, a peak around the average fishing speed and a peak around the average steaming speed. Using the frequency plots, activity is determined for each VMS-point based on the speed recorded. Activity analyses are performed separately for each gear category.

Spatial distribution

The fishing activity determined from the logbooks (kW-days) and the cod landings recorded in the logbooks (kg), are assigned to those (fishing) VMS records that have vessel id, fishing date and fishing position in common. At the spatial scale of $1/4$ degree longitude* an $1/8$ degree latitude ($1/16$ ICES rectangle), the total landings of cod (kg) and fishing activity (kW-days) are calculated. Subsequently LpUE (landings per unit effort) can be calculated for each $1/16$ ICES rectangle by dividing the landings by the activity.

Appendix B. Monthly LPUE cod

In this section the average LpUE for cod are presented by month for quarter 3 for 2014 and 2015 combined. This is representative for the data used by the MMO to determine RTC's.

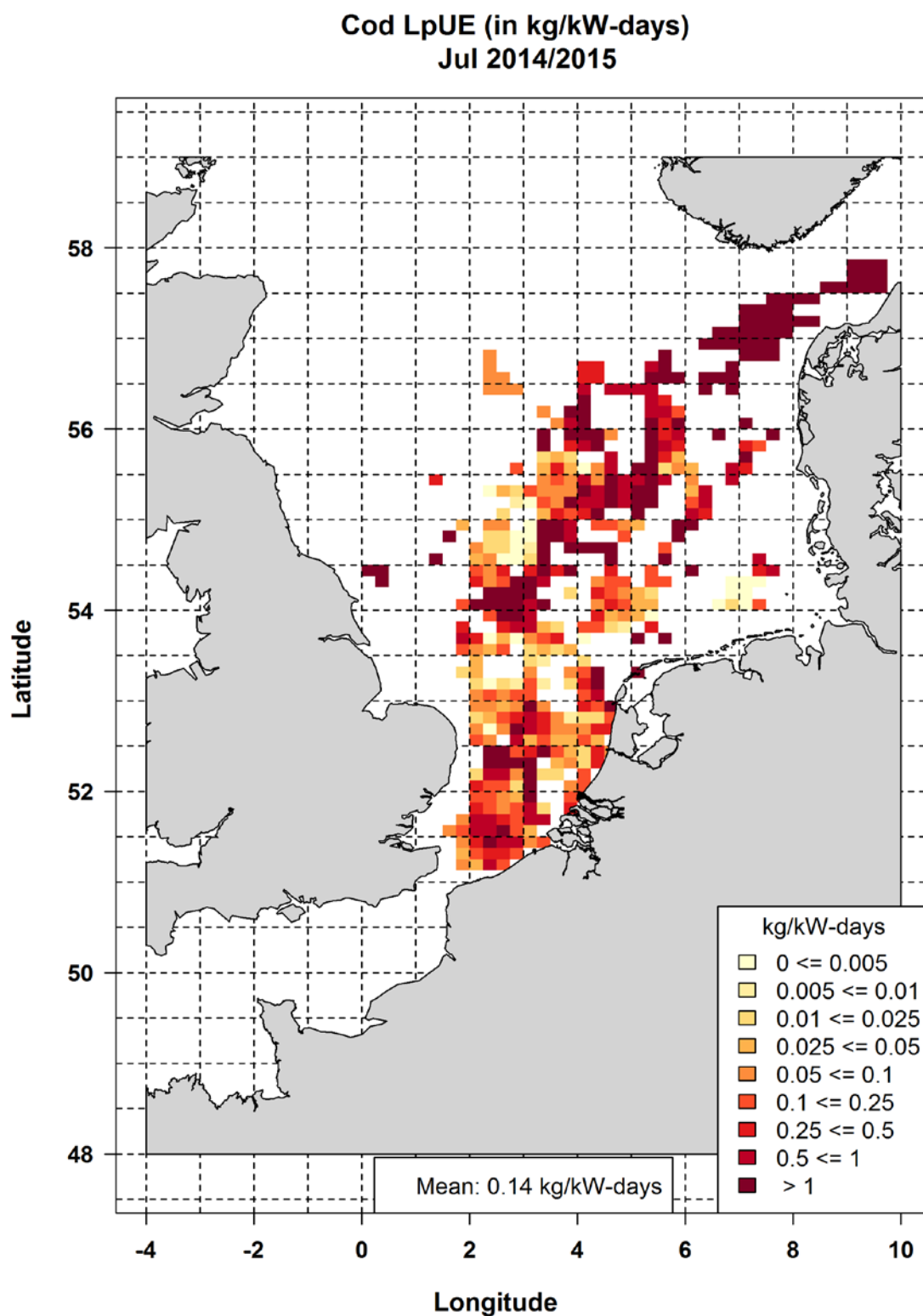


Figure B1 Average cod LpUE (in kg/kW-days) for all TR and BT2 gears together in July 2014 and 2015. The box underneath the map shows the average total LpUE for all gears combined in this month.

**Cod LpUE (in kg/kW-days)
Aug 2014/2015**

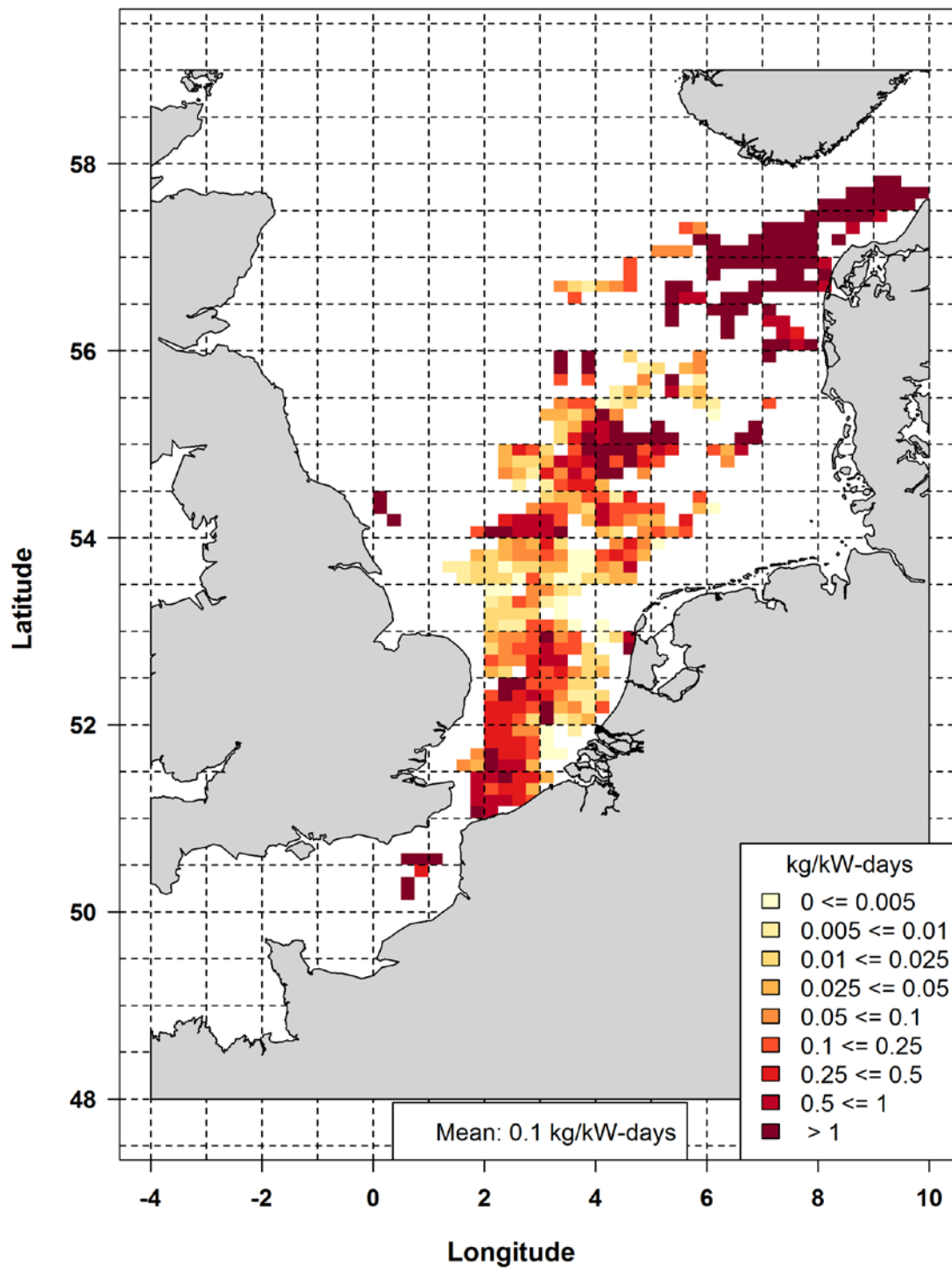


Figure B2 Average cod LpUE (in kg/kW-days) for all TR and BT2 gears together in August 2014 and 2015. The box underneath the map shows the average total LpUE for all gears combined in this month.

Cod LpUE (in kg/kW-days)
Sep 2014/2015

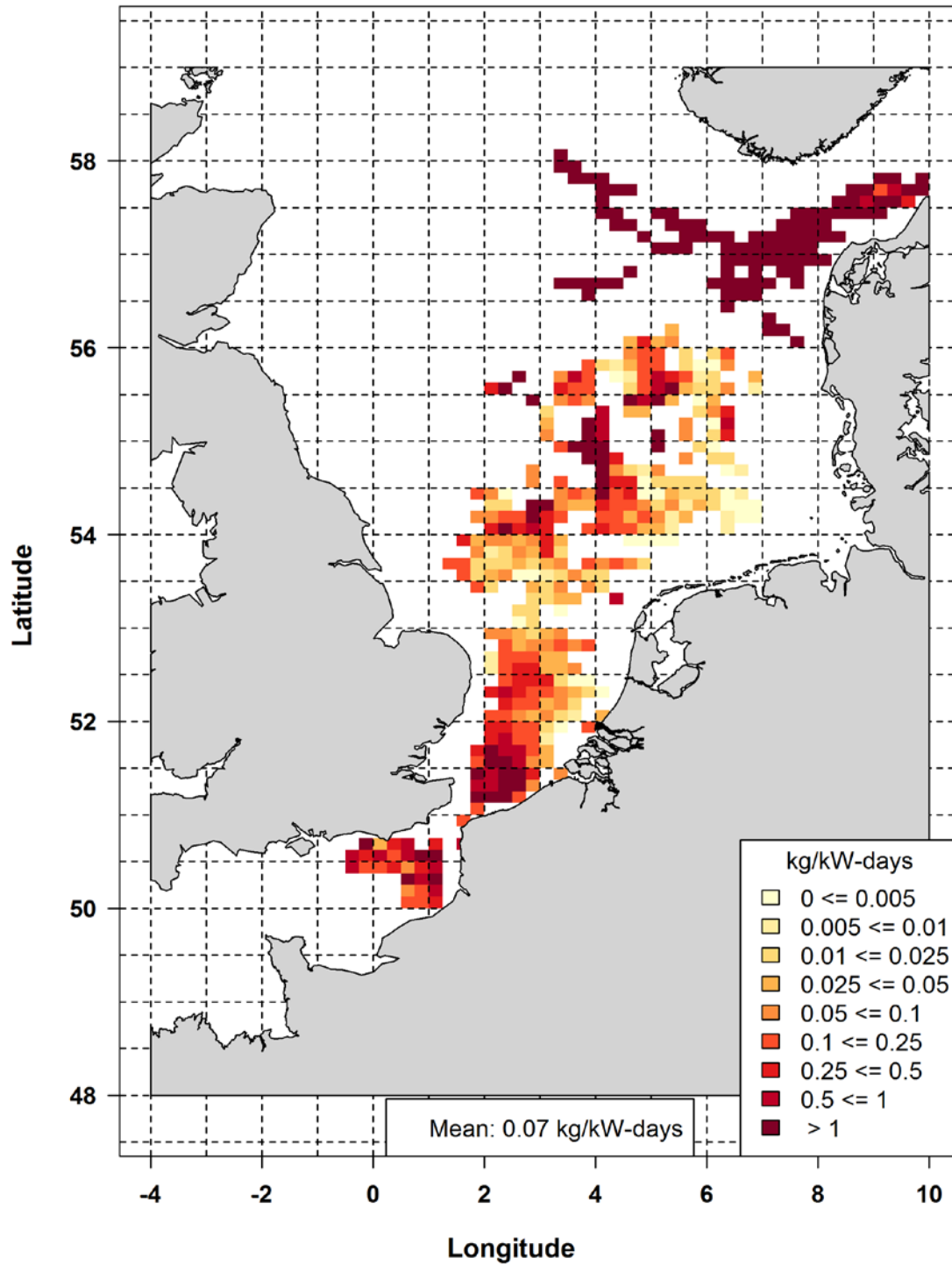


Figure B3 Average cod LpUE (in kg/kW-days) for all TR and BT2 gears together in September 2014 and 2015. The box underneath the map shows the average total LpUE for all gears combined in this month.