Fishing activity near offshore pipelines, 2017-2021

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Summary

On the North Sea bottom lie numerous pipelines to link oil- or gas offshore drilling units, - platforms and processing stations on land. Although pipeline tubes are coated and covered with protective layers, the pipelines risk being damaged through man-made hazards like anchor dropping and fishing activities with bottom trawls.

Fugro Netherlands Marine B.V. works towards integrated risk assessment of potential incidents with pipelines for clients such as TAQA Energy B.V. Spatial maps of fishing activity would contribute to this risk assessment. Therefore, WMR was tasked to quantify the amount of fishing activity in the vicinity of TAQA Energy B.V. pipelines. Fishing activity has been quantified at a spatial scale of approximate 3800 m^2 blocks (68m by 56m) using fishing Vessel Monitoring System (VMS) data in 2017-2021 (01/01/2017-31/12/2021).

The results in this study show that especially beam trawling takes place around the pipelines. Vessels are active within, and outside the 12 mile zone around the pipelines though larger vessels only operate outside the 12 mile zone. In total, between 0 and 6.3 minutes per year of trawling is accumulated over the whole period within each spatial block. A conversion of these numbers to fishing intensity, a measure for number of times a block is fully trawled, shows that sections of the pipeline are trawled between 0 and 2.5 times a year. This fishing intensity is below the range of 5-10 times a year estimated in the most intensively fished areas of the North Sea.

The indicators calculated in this study, reflecting number of potential interactions (fishing effort) of trawling vessels with the pipelines and the potential severity of these interactions (fishing intensity), may contribute to the risk assessment. It should be noted, however, that owing to seasonal changes in fish distribution and yearly changes in fishing gear characteristics, these data/maps do not provide an accurate base for the prediction of future fishing impact.

1 Introduction

On the North Sea bottom lie numerous pipelines and cables to link oil- or gas offshore production and drilling units, - platforms and processing stations on land. Although pipeline tubes are coated and covered with protective layers, the pipelines risk being damaged through man-made hazards like anchor dropping and fishing activities with bottom trawls. Although positions of most pipelines are known (position of older pipelines may be less accurate) an avoidance strategy of the fishing fleet is lacking. Over the past decades, around thirty hits by fishing gear were recorded in the North Sea that resulted in pipeline leaks. Each leak caused by a hit of fishing gear may be associated with substantial environmental and economic consequences. Identifying the risks of such incidents may therefore be important in the overall risk assessment of offshore oil- and gas production activities.
Identifying where fishing operations are most dominant around pipeline tracks at the sea bottom can support additional and better targeted surveying operations, executed by Fugro, to check the integrity of pipelines. Survey results may, in combination with risks of fishing impact, result in tailored approaches to further protect pipelines from impacts or improve the design and position of new pipelines.
This study provides GIS data (shapefiles) of fishing intensities in 2017-2021 in a buffer area around the pipelines that can be used in a GIS application by Fugro to assess risks and advise TAQA Energy B.V. on, for instance, additional survey activities. The addition of a fishing intensity layer to the procedure currently applied by Fugro may improve the overall risk assessment for pipeline damages.

2 Assignment

Within this study, we quantify the amount of fishing effort that is allocated at, or close to, a selection of pipelines by Dutch bottom fishing vessels. In the quantification, measures of uncertainty in the data collected that represents fishing activity, are directly implemented. The final product is a shapefile for the period 2017-2021, containing the pipeline trajectories including a buffer area, and the associated fishing effort and -intensity within these areas at a aggregation level of approximately 3800 m^2 (68m by 56m) grid cells.

3 Materials and Methods

Since the 1st of January 2005 all fishing vessels larger than 15 meters are equipped with VMS and since the 1st of January 2012 the onboard VMS-obligation concerns all vessels larger than 12 meters (note that WMR only has access to Dutch fishing vessels). A VMS transponder sends a signal at regular intervals to a satellite providing information on the vessel's ID, position, time and date, direction and speed. Hence, VMS is a useful data source to study the distribution of the fishing fleet both in time and space. The Dutch ministry of Economic Affairs is tasked with the collection of VMS data of all Dutch fishing vessels. VMS data of foreign vessels, even inside the EEZ, are made irregularly available for scientific purposes. All VMS positions are collected in the WGS84 reference coordinate system.

As VMS signals lack any information on the activities of the fisheries itself, e.g. regarding fishing gear, catch composition, departure harbour or vessel dimensions, for many fisheries related studies, VMS is coupled to fisheries logbooks. These logbooks report per fishing trip (approx. 2 – 5 days) when fishermen leave harbour, what gear has been used to fish, their catch composition and a rough estimate of the location of the catches for each 24 hour period. Both VMS and logbook data report on the fishing vessel ID, which allows for the coupling of the two datasets and study fisheries distribution at finer spatial and temporal scales.

A summary of the VMS data-processing starting with pre-process, analysing VMS- and logbook data, combining these datasets and link gear specific effort to the pipelines is given below. A more detailed description on the processing and assumptions made during this process can be found in Hintzen et al. (2013); http://edepot.wur.nl/248628.

Data pre-processing:

- VMS and logbook data are received from the Ministry of LNV and stored in a local database at WMR.
- VMS records are considered invalid and therefore removed from the analyses when they:
    - are duplicates or pseudo-duplicates (indication of malfunctioning of VMS device)
    - identify an invalid geographical position
    - are located in a harbour
    - are located on land
    - are associated with unrealistic vessel speeds (> 20 knots)
- logbook records are removed from the analyses when they:
    - are duplicates
    - have arrival date-times before departure date-times
    - overlap with other trips

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
- Fishing trips, using bottom gear types like beam trawlers (referred to with code TBB), otter trawlers (OTB), dredges (DRB and HMD) & Scottish seines (SSC), showing VMS signals around the pipelines track [between latitudes 51.7°N and 52.6°N ; longitudes 3.2°E and 4.6°E] are selected (gears such as gillnets or midwater trawls are not taken into account given their limited to non-existing contact with the seabed when in operation).
- Only VMS and logbook data of the time period 01-01-2017 to 31-12-2021 are used and analysed per full year.

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 being in harbour/floating, a peak around the average fishing speed and a peak around the average steaming speed. These analyses are performed separately per gear type for two kW classes (<= 225kW and > 225kW) as these vessel types show different fishing behaviour and are allowed to fish in different regions.
- According to the method described above, a number of VMS records can be associated with fishing activity, depending on the gear used by the vessel. In general, vessel speeds between 1.5 and 8 knots are characterized as fishing. For small beam trawlers the selected range was approximately 2-7 knots. For large trawlers the range was approximately 4-8 knots.

Increase spatio-temporal resolution:

- VMS recordings are available for fishing vessels approximately every half hour. When the vessel speed is 4 knots, the trawling distance between two successive VMS locations, at ½ hour pings intervals, is approximately 4 km. Although on a yearly basis this amounts to a vast amount of spatial data, for studies such as the current one, additional detail is required to appropriately link a pipeline route to crossing fishing vessels activities. For this purpose, an interpolation routine is used which estimates intermediate locations between two successive VMS pings. The routine used in this study is described in detail in Hintzen et al., 2010. On average, an additional 700 points are added in between two successive VMS pings which are by default two hours apart, resulting in a dataset with pings intervals of 10 seconds.

Define area of interest:

- In total 61 km^2 pipeline trajectories and buffers were identified that needed investigation in this study. They are located near the North Sea coast within the ICES rectangles 32-33/F3-F4 (see Figure 1). The study area has further been divided into small squares (a grid) of ~68m by 56m blocks to allow for more detailed spatial analyses.

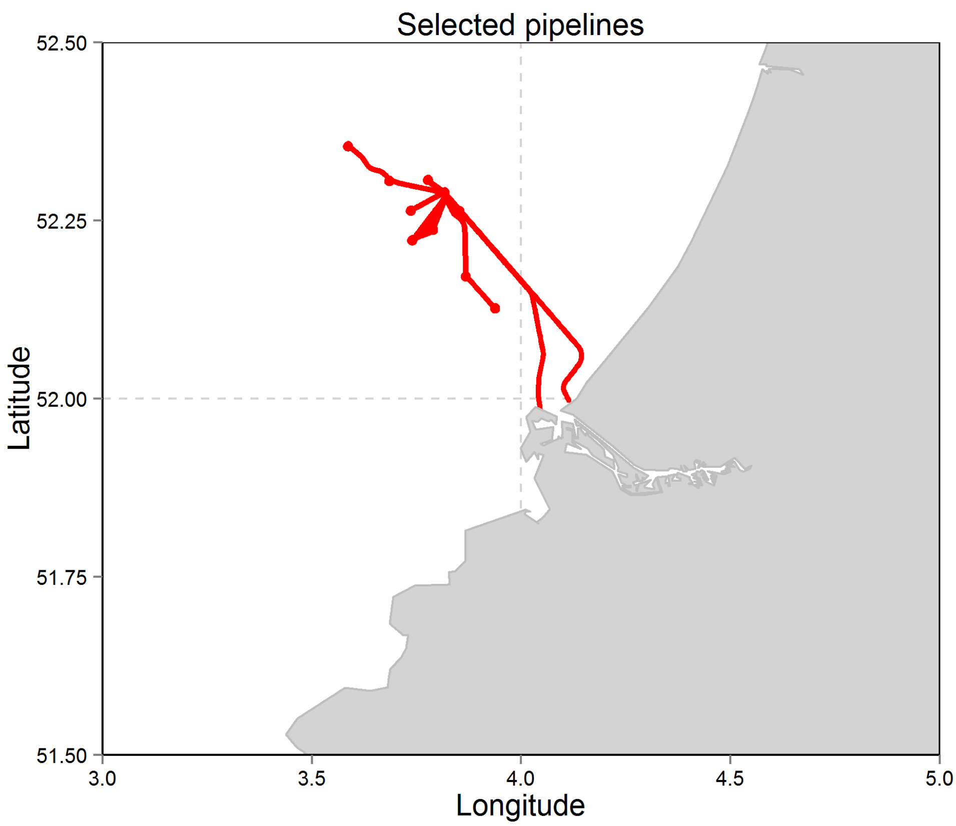

Figure 1. *Dutch North Sea coast and locations of pipelines included a buffer area around pipelines (61 km^2) overlaid with 3 ICES rectangles 33F3-4 & 32F3 (bordered by grey straight dotted lines).*

Link pipeline location to fishing effort:

- We assume that a pipeline hazard may be caused by a build-up of smaller damage events caused by passages of active fishing vessels using bottom gears. The exact route of fishing vessels is however uncertain given that only every 2 hours exact vessel position data is collected and stored. Therefore, the increased spatio-temporal resolution improvements have to be made. This however, does not account for uncertainty in this interpolation method. Additionally we assume that activity is certain at the locations from which a VMS ping was send to the satellite, but certainty decreases in between these time stamps and decreases further away from the interpolated track. This together creates a 2-dimensional confidence interval for each fishing vessel movement, which can be scaled to represent the interval hours of fishing in total. Figure 2 gives a graphical representation of the interpolation and confidence interval calculation.

Note that each grid cell then represents a certain amount (measured in minutes) of fishing activity. This uncertainty is calculated assuming a grid of 68x56m blocks. By cumulating the fishing effort of all vessels of the fleet under consideration, the grid cell values reveal detailed spatial information of fishing activities during a year. By multiplying the fishing activity by gear with the fishing speed and gear width, and dividing by surface area of each grid cell, we calculate the fishing intensity. Finally, the pipeline location and buffer is overlaid onto the fishing activity grid to link the fishing effort to each pipeline location. A shapefile is created containing the fishing activity by grid cell bounded by the pipeline trajectories.

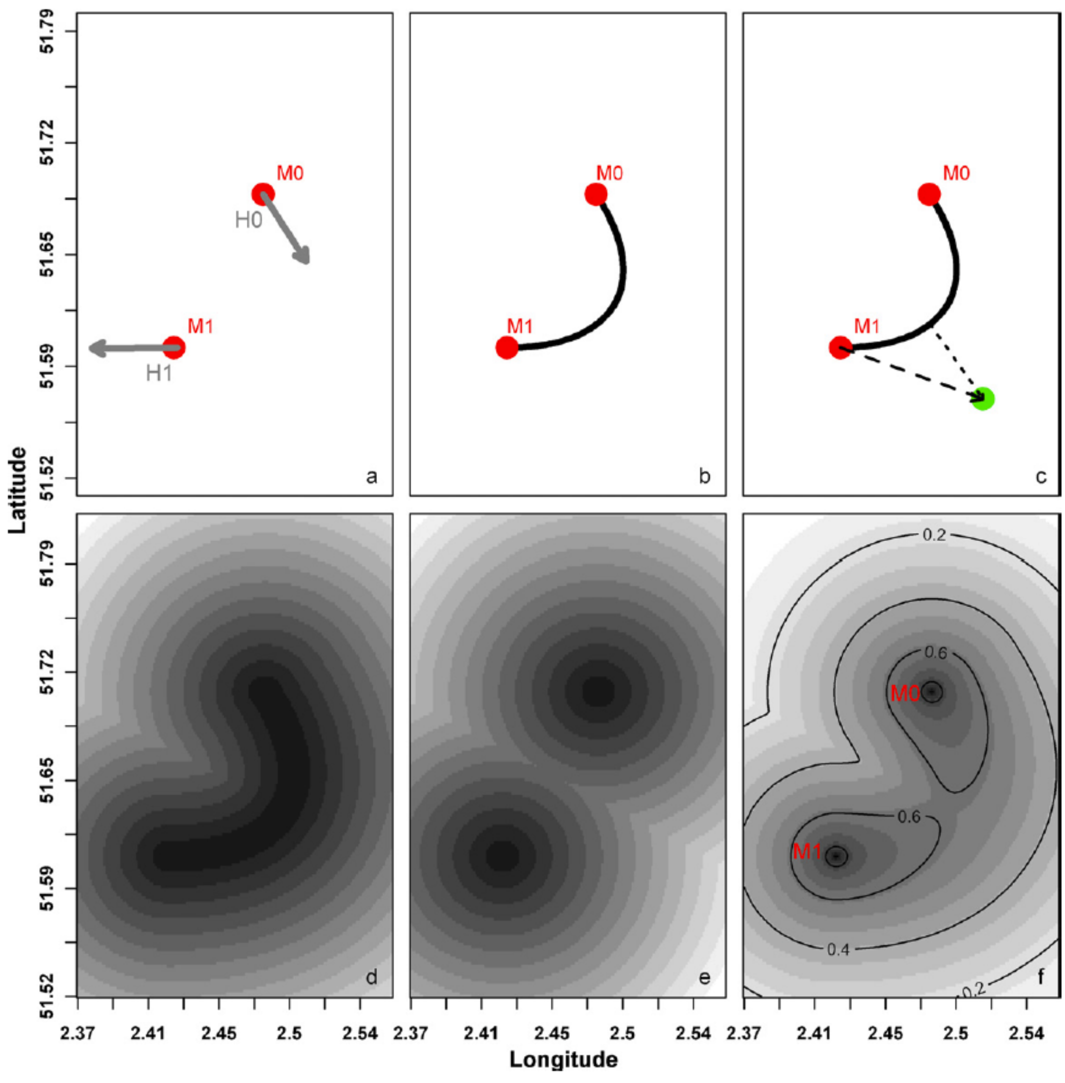

Figure 2. *Schematic representation of the interpolation process starting with two succeeding VMS position registrations towards an estimated track surrounded by a confidence interval. (a) The start and end point of the vessel are represented by* M_0 *and* M_1 *respectively, the heading of the vessel at start- and end-point are represented by the small arrows* H_0 *and* H_1*. Based on the value of a scaling parameter these arrows become longer/shorter influencing the curvature of the interpolation (see panel b). For small values of this parameter, the interpolation will approximate a straight line between* M_0 *and* M_1*. (b) Interpolated track based on cubic Hermite spline (black solid line). (c) The parameter DSD for a random point on a grid (green dot) depends on the distance marked by the dashed arrow (black dashed arrow) from M1 to the green dot. (d) Shortest distance from each point on a grid to the interpolated track. Lighter grey represents more distant grid cells. (e) Shortest distance from each point on a grid to either M0 or M1. Lighter grey represents more distant grid cells. (f) Interpolation between two succeeding VMS data points surrounded by a confidence interval. At positions M0 and M1, values equal one.*

Results are presented for four different fleet segments that differ in gear design, namely dredge, beam trawl, otter trawl and shrimp trawl. Dredge is known to penetrate the seafloor deepest but fishes at low speeds while beam trawl penetrates the seafloor substantially as well and trawls as higher speeds. The gear is heavy as well. The otter trawl only penetrates the seafloor by the 'doors' of the gear, two steel plates that keep the fishing net open due to drag. The shrimp trawl is lighter than the beam trawl gear and fishing takes place at slower speeds as well. The risks associated with these fleet segments may therefore also vary.

4 Results

The area of interest and pipeline trajectories, as provided by Fugro, is shown in Figure 1. ICES rectangles are squares of 1 degree longitude by 0.5 degrees latitude and follow a naming convention that covers the entire North East Atlantic. Fisheries logbook data is recorded at the ICES rectangle level. It is therefore that the study focusses on three ICES rectangles in the vicinity of the pipelines.

The Dutch fishing effort in the area of interest in 2017-2021 is mapped in figure 3. Legends are kept the same between years to accommodate visual comparisons. The underpinning data is provided to the client as shape files.

Red grid cells show the highest fishing effort or intensity and lowest efforts or intensities are given in blue. The actual values are shown in the palettes right of the figures.

Figures 3 & 4 show fishing effort and fishing intensity of the dredge, beam trawl fleet, otter trawl fleet and shrimp trawl fleet separately. Fishing effort is given as total time (hours) fishing vessels were fishing in grid block cells of 68m by 56m. Fishing intensity is given as the total number of times a grid cell is fully trawled, i.e. total area trawled per grid cell divided by the surface area of a grid cell.

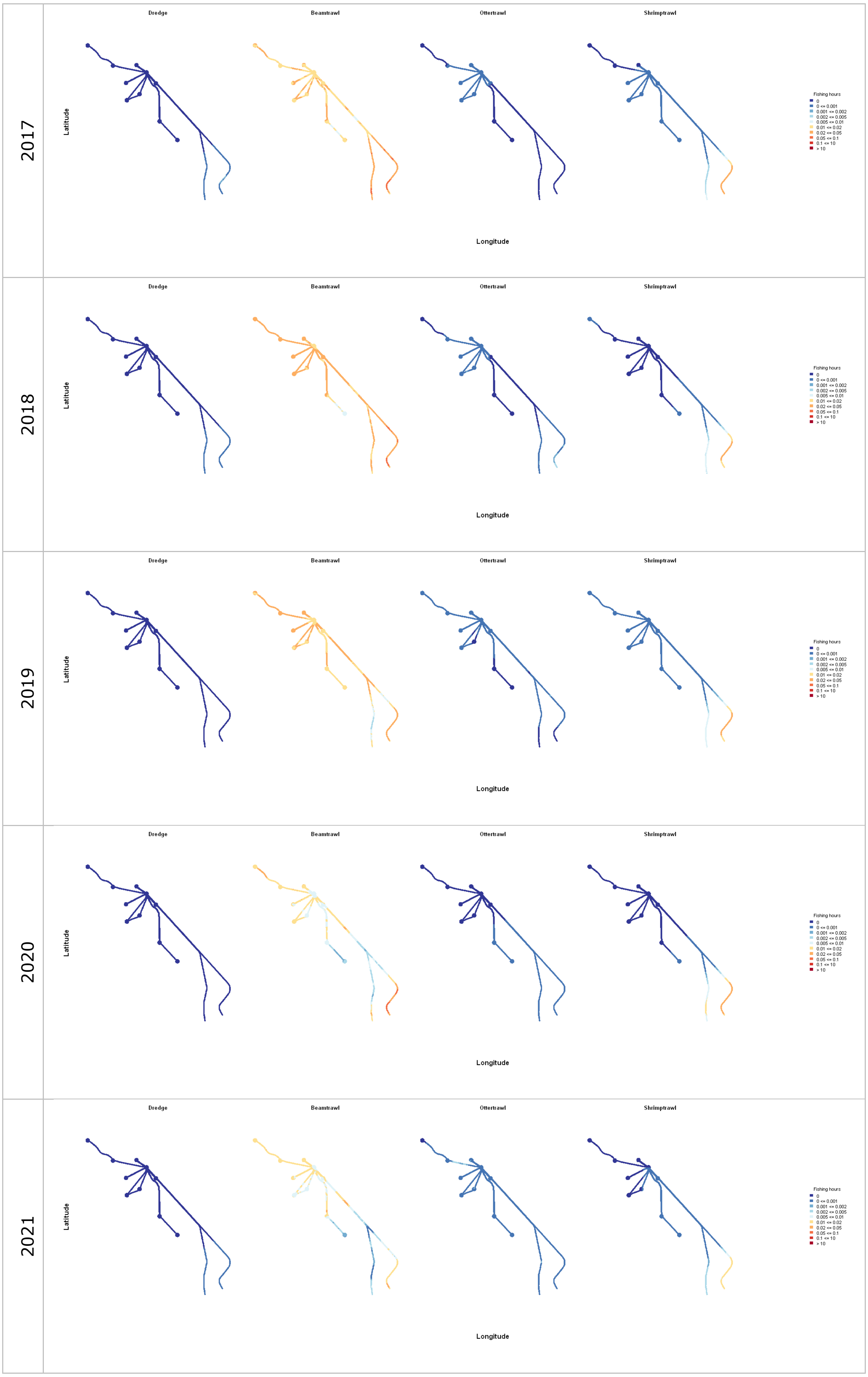

Figure 3. *Fishing effort grid-map of all bottom gears in 2017-2021. The grid cell dimensions are 68m by 56 m and the colour indicates the total amount of fishing effort in hours (see palette). The buffer area around the pipelines are also shown (grey lines).*

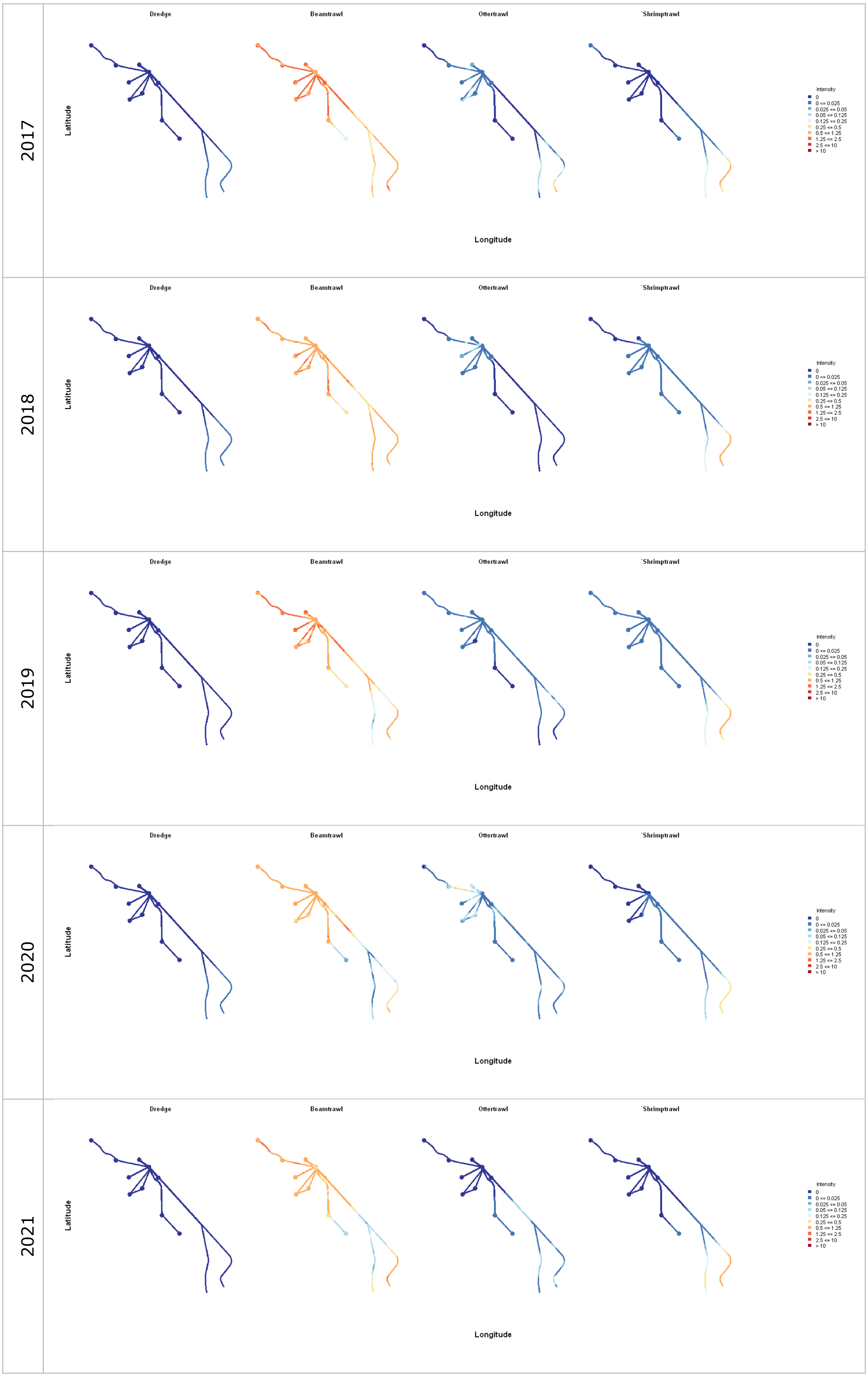

Figure 4. *Fishing intensity grid-map of all bottom gears in 2017-2021. The grid cell dimensions are 68m by 56m and the colour indicates the total amount of fishing effort in hours (see palette). The buffer area around the pipelines are also shown (grey lines).*

The spatial pattern suggests that the smaller beam trawlers, that are allowed to fish within the 12-mile zone, have moved away from the more coastal area of the pipeline segments while the larger vessels, operating outside the 12-mile zone, have reduced fishing activity all together. There is a decline in overall fishing activity visible (figure 5) for the beam trawl fleet. The spatial pattern for the shrimp trawl fleet varies across years but there is no clear trend.

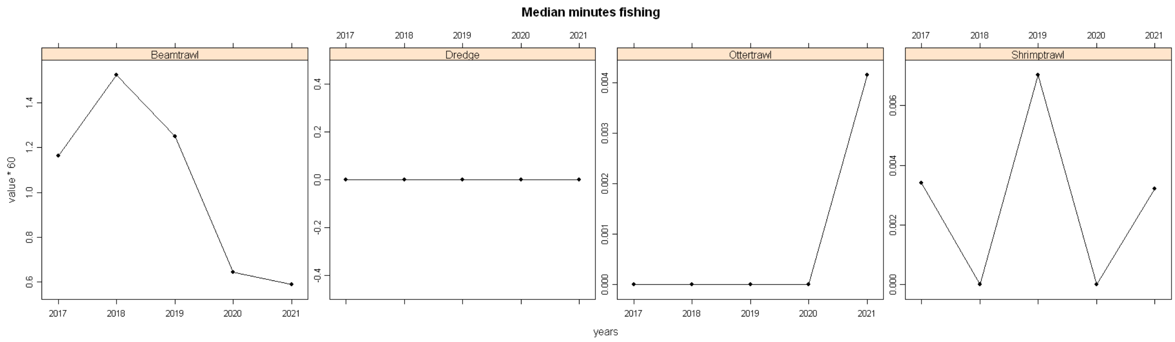

Figure 5. *Median fishing minutes over all grid cells within the TAQA buffer area for the four different fleet segments throughout the years 2017-2021.*

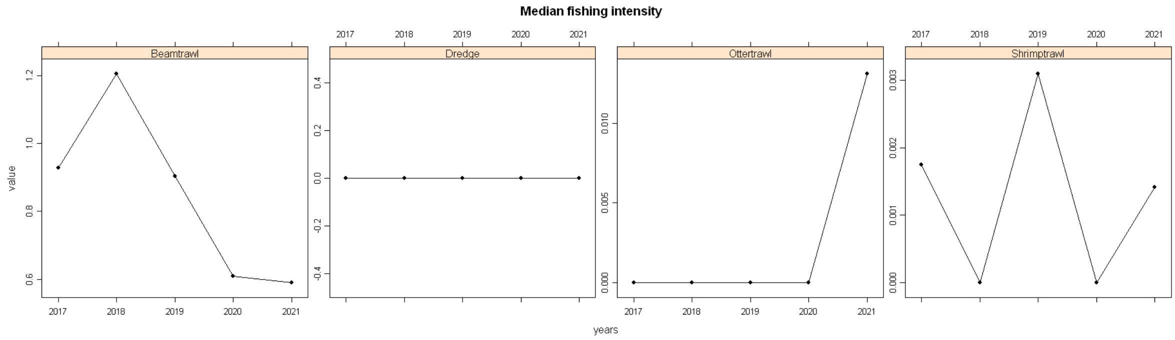

Figure 6. *Median fishing intensity over all grid cells within the TAQA buffer area for the four different fleet segments throughout the years 2017-2021.*

In the area examined the fishing effort found originated mainly from beam trawlers. The overall mean of total fishing effort per grid cell (n=16008) is 1.5 trawling minutes in 2018 and declines after that year to around 0.6 minutes in 2021 (See figure 5). The other gears have a substantially lower median amount of fishing activity. The shrimp trawl is however active in the lower right hand corner, the area closest to shore.

The overall mean of total fishing intensity per grid cell is 1.2 times in 2018 and declines after that year to around 0.6 times in 2021 (See figure 6). The other gears have a substantially lower median amount of fishing activity.

5 Conclusions and recommendations

The results from this study show that the fishing activity in 2017-2021 of the beam trawl fleet are most relevant in the study area, and that fishing activity of otter trawlers, dredges and shrimp trawl is minimal, except for the area closest to land where shrimp trawl is present. The beam trawlers account for more than 95% of all fishing effort in the study area. From a risk perspective, these gears may be more important than otter trawlers or shrimp trawls too, as they tow heavy gears over the seafloor while otter trawlers and shrimp trawls tow much smaller metal plates and beams over the seabed at lower speeds, limiting the amount of pipeline surface they can damage.

The results suggest no obvious avoidance strategy for pipelines is in place. The distribution of VMS pings in close vicinity of the pipelines is similar to areas further away from the pipelines. No direct 'attraction' of fishing activity to pipelines could be observed either, but indications of this would require further in-depth analyses.

6 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system. The organisation has been certified since 27 February 2001. The certification was issued by DNV.

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Justification

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Project Number: 4316100281

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

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