Fishing activity near Petrogas offshore pipelines, 2024

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Summary

The North Sea seabed contains numerous pipelines that connect offshore oil and gas drilling units, platforms, and onshore processing stations. Despite being coated and protected, these pipelines are vulnerable to damage from human-induced hazards, including anchor drops and fishing activities such as bottom trawling.

Petrogas E&P Netherlands B.V. is working on an integrated risk assessment of pipeline vulnerabilities, with spatial maps of fishing activity playing a key role. To support this effort, WMR was tasked with quantifying fishing activity near the company's pipelines. The analysis used Vessel Monitoring System (VMS) data from 2024 to measure fishing activity within grid cells of approximately 3800 m² (68m by 56m). Fishing activity was assessed using two metrics: fishing intensity (number of times a grid cell is trawled) and total fishing effort (in minutes) per grid cell.

The results revealed that both larger and smaller vessels operate in areas near pipelines, particularly those closer to shore. In the northern part of the Exclusive Economic Zone (EEZ), fishing intensity is low for larger vessels and negligible for smaller vessels and shrimp trawlers. The highest fishing intensity was recorded near the IJmuiden harbour, driven by shrimp trawling activity, with an estimated trawling intensity of 3-4 occurrences per year around the pipelines. This intensity, however, is lower than the 5-10 occurrences per year found in the North Sea's most heavily fished areas. Notably, the gear used for shrimp trawling is much lighter than traditional beam trawls.

The indicators derived from this study—fishing effort and fishing intensity—can help inform the risk assessment of potential interactions between trawling vessels and pipelines. However, it's important to note that these maps are not predictive of future fishing impacts due to seasonal variations in fish distribution and yearly changes in fishing gear characteristics.

1 Introduction

Numerous pipelines lie on the North Sea seabed to link oil or gas offshore drilling units to platforms and processing stations on land. Although pipeline tubes are coated and covered with protective layers, the pipelines risk being damaged through human-induced hazards like anchor dropping and fishing activity with bottom trawls. Despite the positions of most pipelines being known (position of older pipelines may be less accurate) an avoidance strategy of the fishing fleet is lacking. Over the past decades, several hits by fishing gear have been known to result in pipeline leaks in the North Sea. Each leak caused by a hit by fishing gear may be accompanied by substantial environmental and economic risks. Identifying these risks is therefore important in the overall risk assessment of offshore oil- and gas production activities.

Identifying where and which fishing operations are most dominant around pipeline tracks at the sea bottom can support additional and better targeted surveying operations, 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. Larger vessels, with more engine power and heavier fishing gear, may cause more damage than smaller vessels.

This study provides maps and shapefiles of fishing intensity in 2024 in a buffer area around the pipelines that can be used in a GIS application by Petrogas E&P Netherlands B.V. to assess risks and advise on, for instance, additional survey activities.

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 full year of 2024, containing the pipeline trajectories including a buffer area (200m), and the associated fishing effort and -intensity within these areas at an aggregation level of 3800 m^2 (68m * 56m) grid cells.

3   Materials and Methods

Since the 1st of January 2005 all fishing vessels larger than 15 meters are equipped with Vessel Monitoring Systems (VMS), and since the 1st of January 2012 the on-board VMS-obligation concerns all vessels larger than 12 meters. A VMS transponder sends a signal to a satellite at regular intervals providing information on the vessel's ID, position, time & 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 Netherlands Food and Consumer Product Safety Authority (NVWA) is tasked with the collection of VMS data of all Dutch fishing vessels. VMS data of foreign vessels, even inside the Dutch EEZ, are not available to WMR 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 course grid cell 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, analysis of VMS- and logbook data, combining these datasets and linking 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 Netherlands Enterprise Agency (RVO) 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 or their recording)
    - identify an invalid geographical position
    - are located in a harbour
    - are located on land
    - are associated with vessel speeds > 20 knots
- logbook records are removed from the analyses when they:
    - are duplicates
    - have arrival date-times before departure date-times
    - overlap in time with another trip of the same 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
- Fishing trips using bottom gear types, including beam trawlers (referred to with code TBB), otter trawlers (OTB), dredges (DRB and HMD) and Scottish seines (SSC), showing VMS signals around the pipelines track [between latitudes 52 and 56;longitudes 3 and 5] were selected for further analysis (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 year 2022 are used.

Defining 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, which is associated with being in harbour/floating, followed by a peak around the average fishing speed, and a peak around the average steaming speed. The analyses on speed thresholds to define the activity of a ship 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.
- Using the method described above, part of the VMS records can now be classified as fishing activity. 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.

Increasing spatio-temporal resolution:

- VMS recordings are available for fishing vessels approximately every 0.5 - 2 hours. When the vessel speed is 4 knots, the distance between two successive VMS recordings at 0.5 hour pings intervals, is approximately 4 km. For studies such as the current one, more spatially refined information 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, also using information on headings and speeds. 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.

Defining area of interest:

- In total 260 km of pipeline trajectories was identified that needed investigation in this study. They are located in the North Sea coast off IJmuiden and in the northern part of the Dutch EEZ (see Figure 1). The study area has further been divided into small squares (a grid) of ~68x56 m blocks to allow for more detailed spatial analyses.
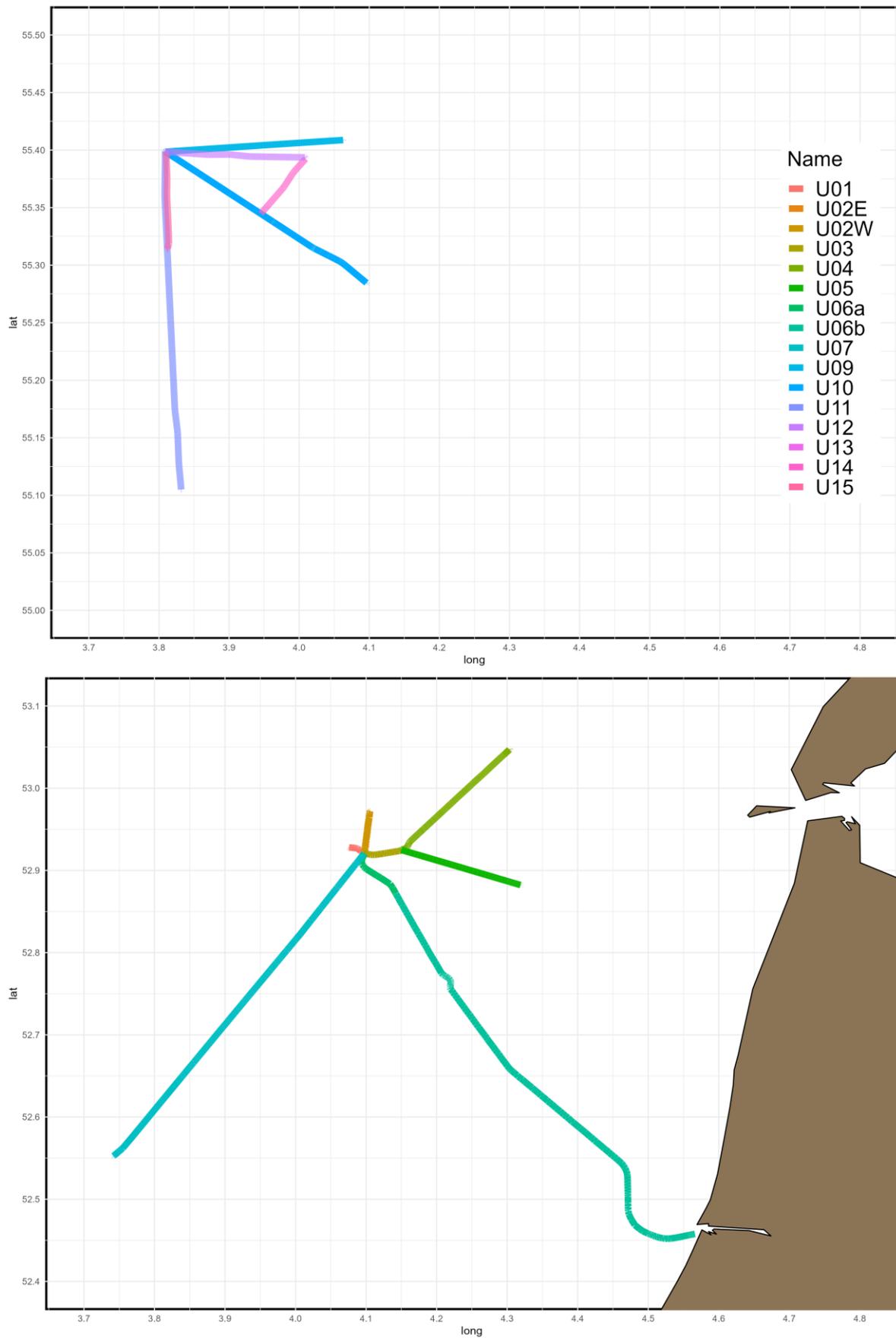
Figure 1. *Dutch North Sea coast and locations of pipelines. The top figure shows the pipelines in the Northern Dutch EEZ, the bottom figure shows the pipelines off the Dutch coast at IJmuiden.*

Table 1. *Description of Petrogas pipelines considered in this study.*

Name	Description	New since 2021
U01	Helder-B to Helder-A	No
U02E	Haven-A to Helder-A (East)	No
U02W	Haven-A to Helder-A (West)	No
U03	Hoorn-A to Helder-A	No
U04	Hoorn-A to WGT Side-Tap	No
U05	Halfweg to Hoorn-A	No
U06a	Helder-A to Helm	No
U06b	Helm to IJmuiden	No
U07	Horizon to Helder-A	No
U09	A12-CPP to B10 Side-Tap	No
U10	B13-A to A12-CPP	No
U11	A18 to A12-CPP	No
U12	B10 to B13 pipeline Side-Tap	Yes
U14	B10 to A12	Yes

Linking 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 not given by VMS data, given that exact vessel position data is collected and stored only every 2 hours. Therefore, interpolations need to be made between VMS pings to estimate fishing routes. 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 sent 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 is overlaid onto the fishing activity grid to link the fishing effort to each pipeline location. A shape file is created containing the fishing activity in minutes by grid cell bounded by the pipeline trajectories.
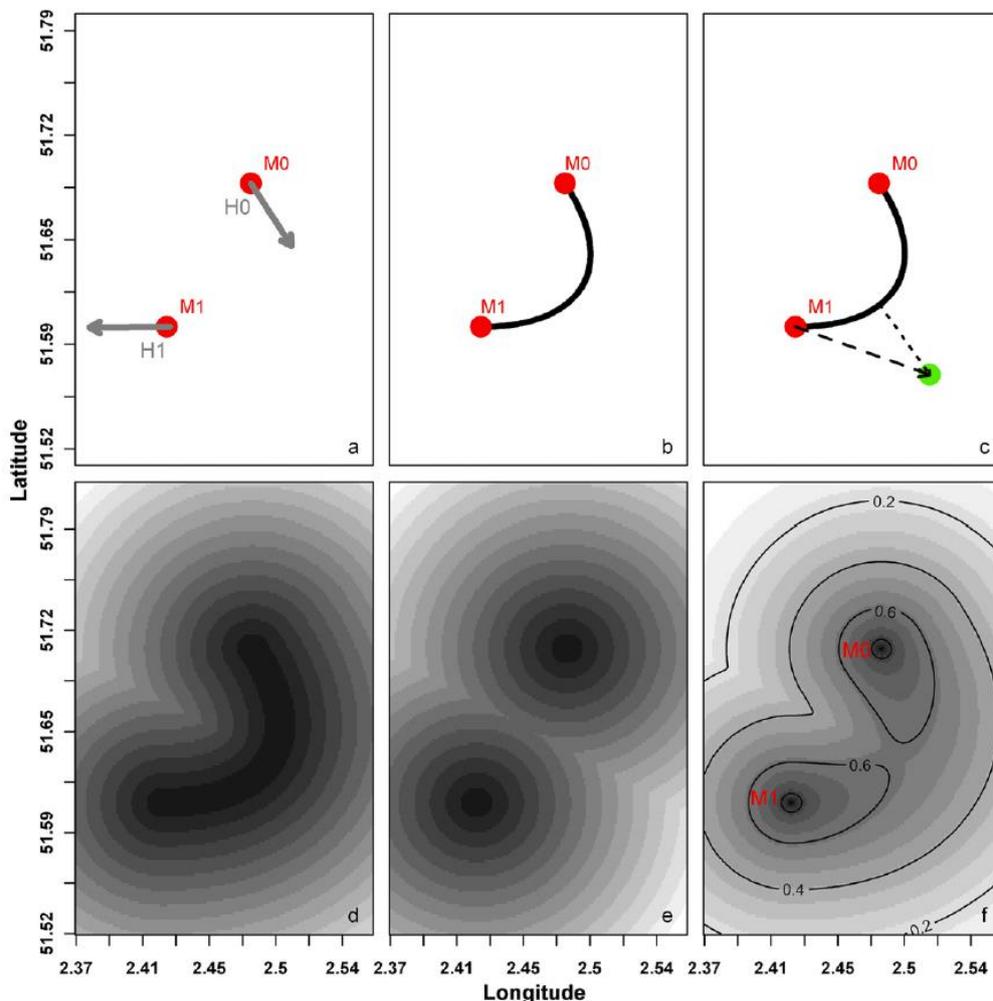
Figure 2. *Schematic representation of the interpolation process starting with two succeeding VMS position registrations towards an estimated track surrounded by a confidence interval. (a) The start and end point of the vessel are represented by M_0 and M_1 respectively, the heading of the vessel at 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.*

Calculation of fishing intensity

The confidence intervals, which represent the fishing intensity in minutes, are thereafter converted into swept-area estimates based on average speed and gear width of the gears considered (beam trawl including pulse and shrimp trawl, otter trawls, dredge and flyshoot). Vessels with engines larger than 300hp were grouped into the category of large vessels and vessels with engines lower than 300hp, excluding shrimp trawls, were grouped into the category of small vessels. Due to the low weight of the gear of the shrimp trawls, these were considered separately.

The swept-area estimates for each of these three gear groups was converted into swept area ratio (SAR) estimates by dividing the swept-area estimate per grid cell by the surface area of the grid cell. This indicator, often referred to as fishing intensity, is a proxy for the number of times a grid cell near a pipeline has been fished, although it is not explicitly the same. For example, a SAR value of 1 means the surface fished is exactly the surface area of the grid cell, however, part of the cell could be fished more than once and part of the cell less than once.

4   Results

The results are shown for the three gear groups: large vessels, small vessels and shrimp trawls at each of the pipelines considered in the study. The maps below show, per pipeline segment, on the left-hand panel the fishing intensity in minutes for large vessels (>225 kW). The center plot shows fishing intensity for shrimp fishing vessels. On the right-hand side, the same map is given for small vessels (< 225 kW). Fishing intensity expressed as SAR is provided in shapefiles but not shown in this report. The black dots in the plots are a random subset (~10%) of the actual VMS pings the analyses is based on, due to readability and data confidentiality. Absence of dots may be due to the fact that they fall outside the plotted areas. For each vessel size category the pipelines close to the Dutch coastline and in the northern part of the EEZ are presented separately. Shapefiles of each pipeline segment is made available to the client.
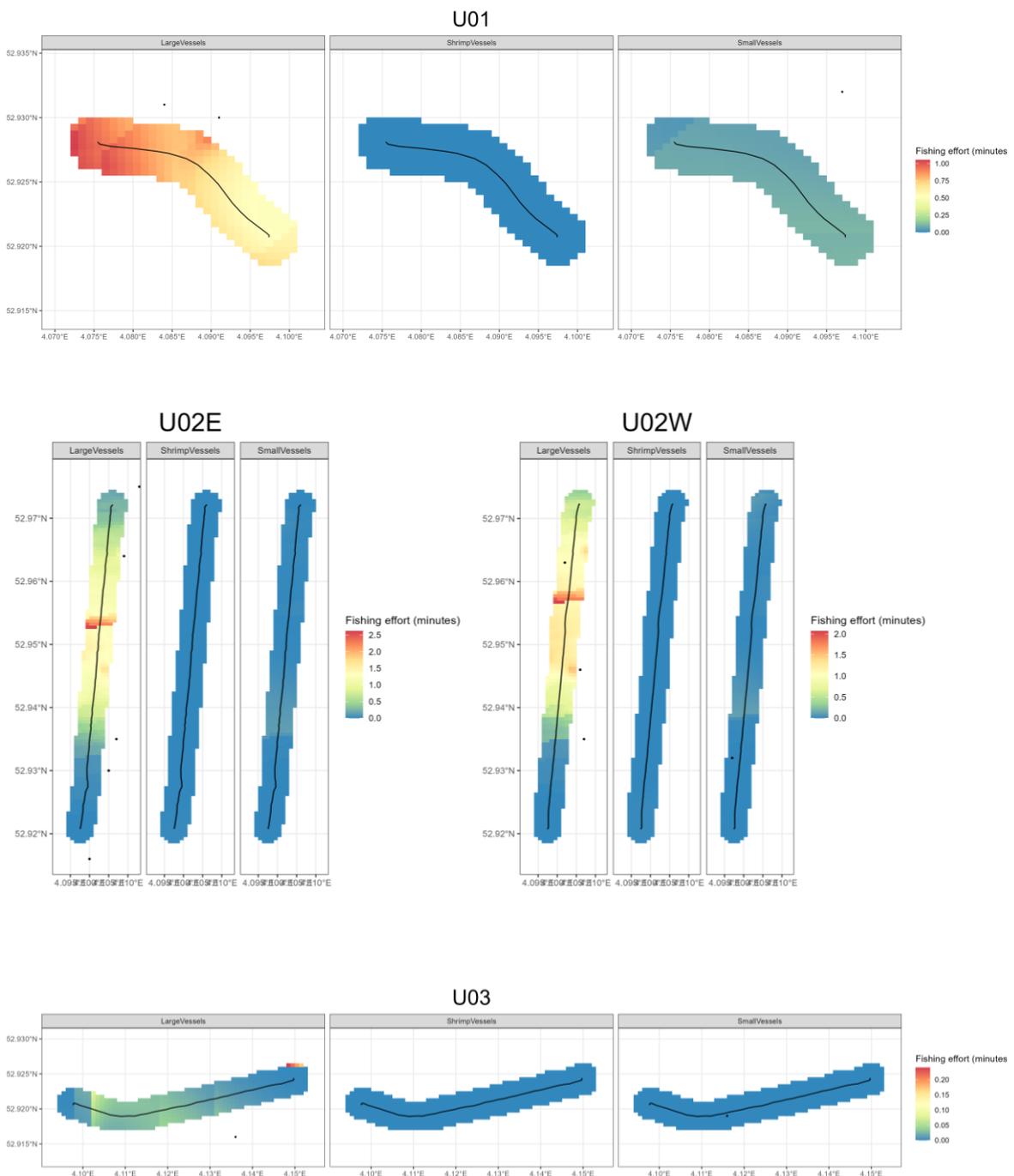
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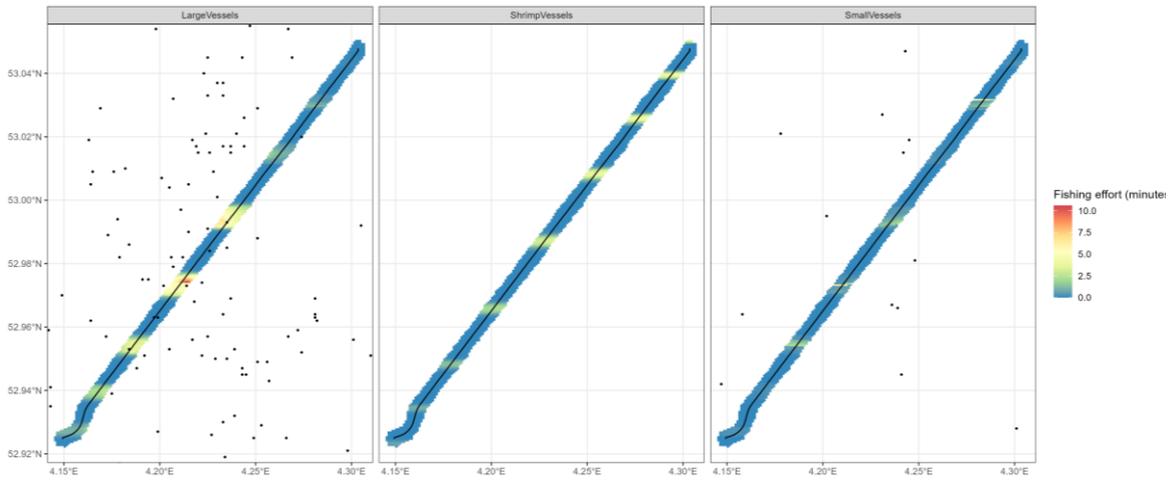
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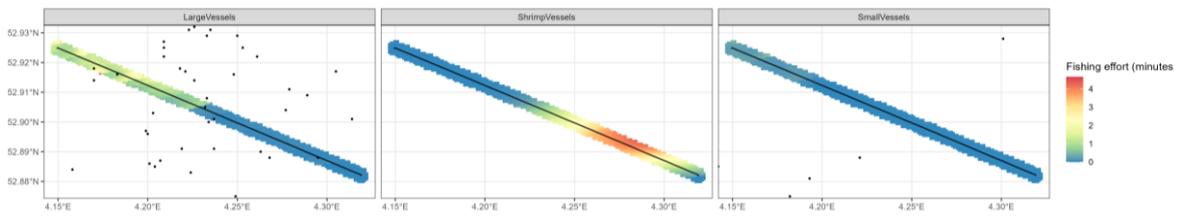
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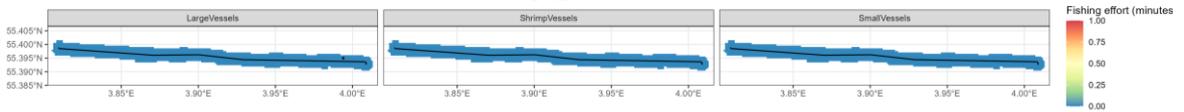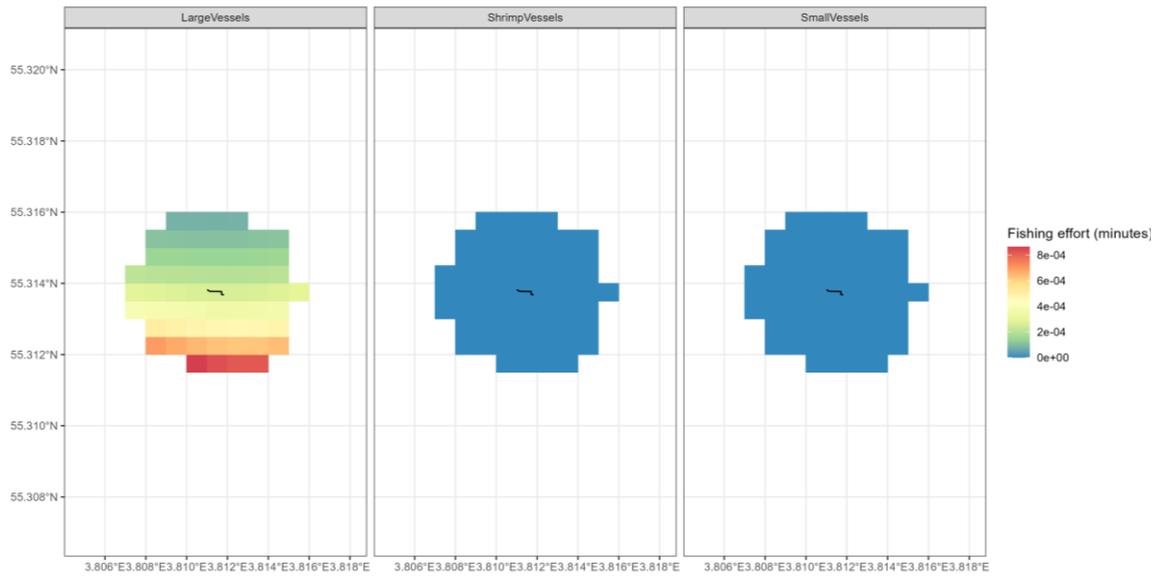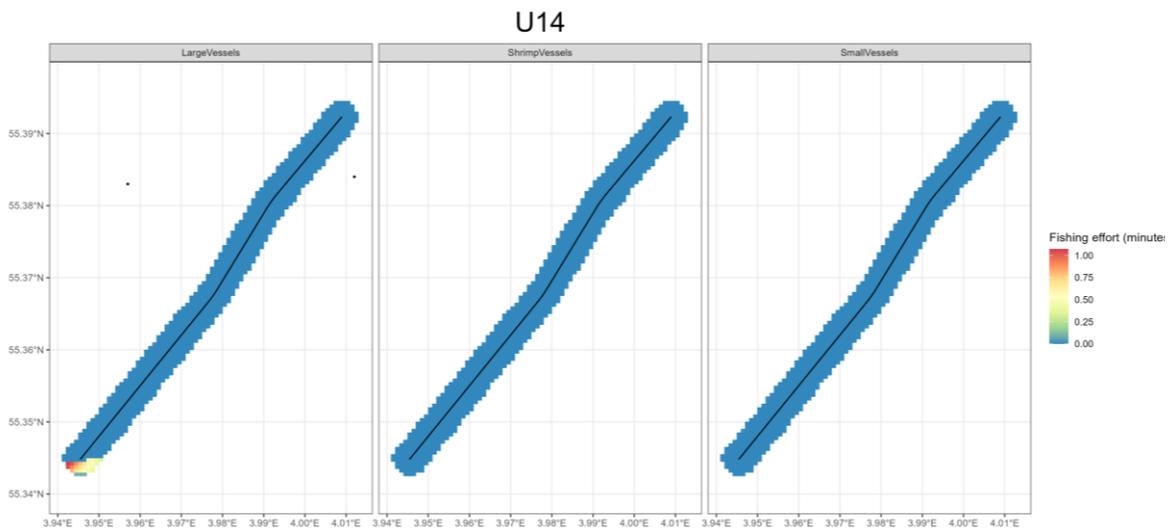## U10
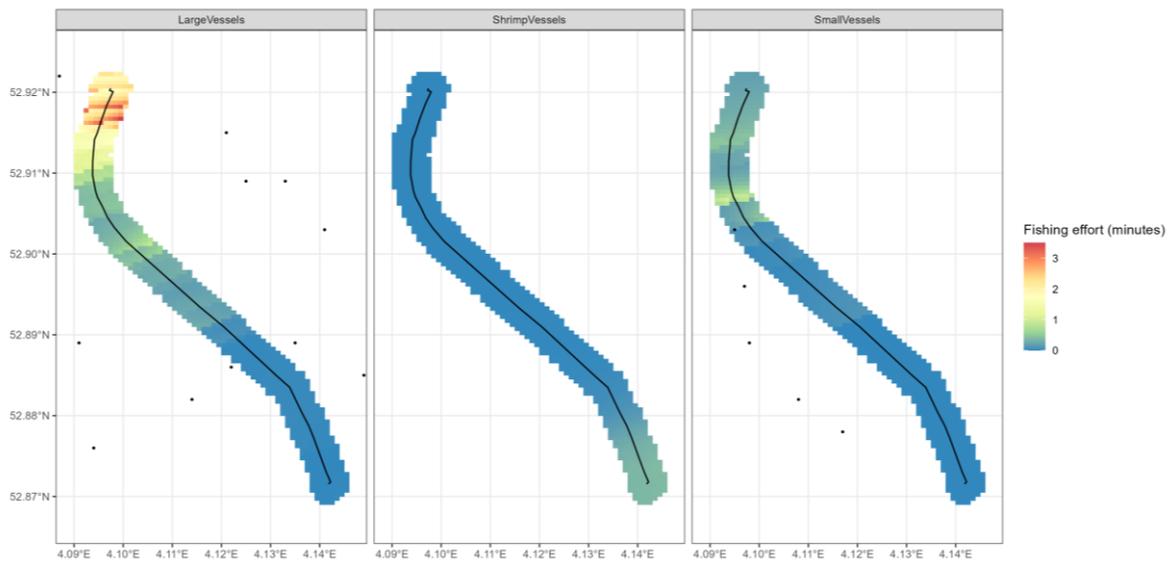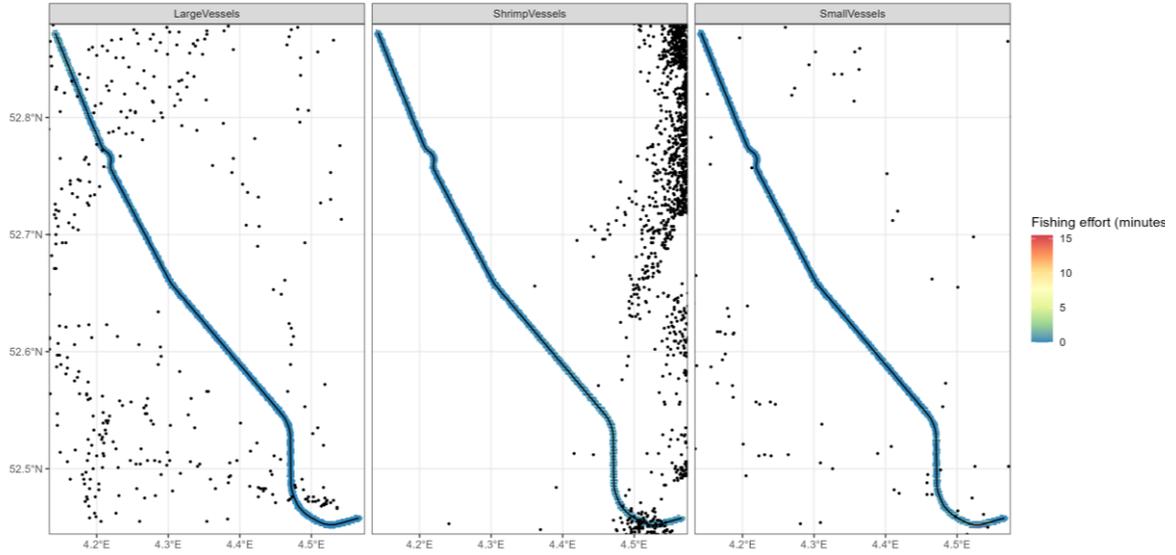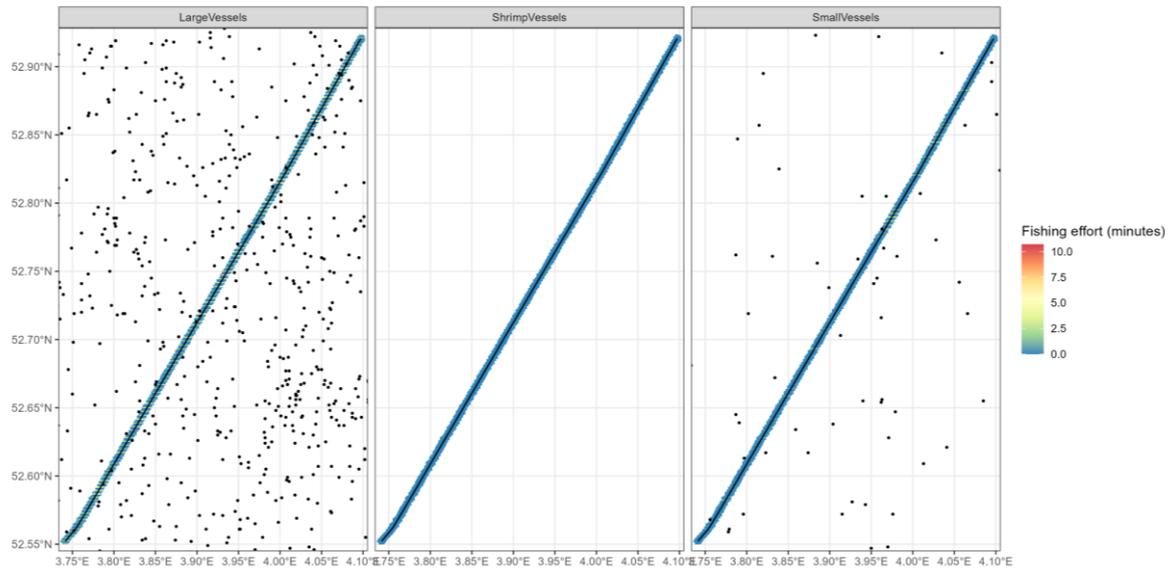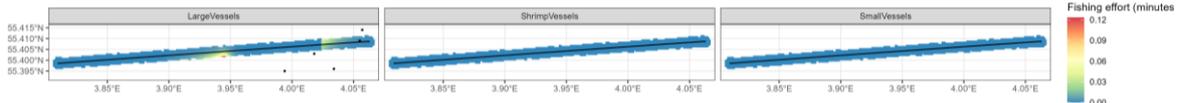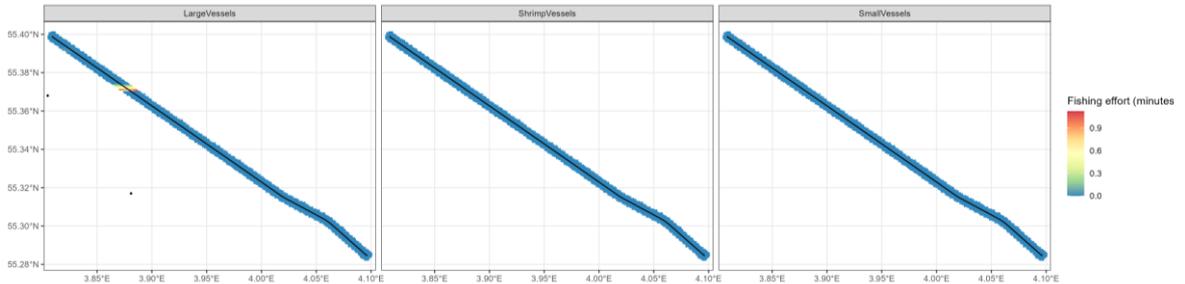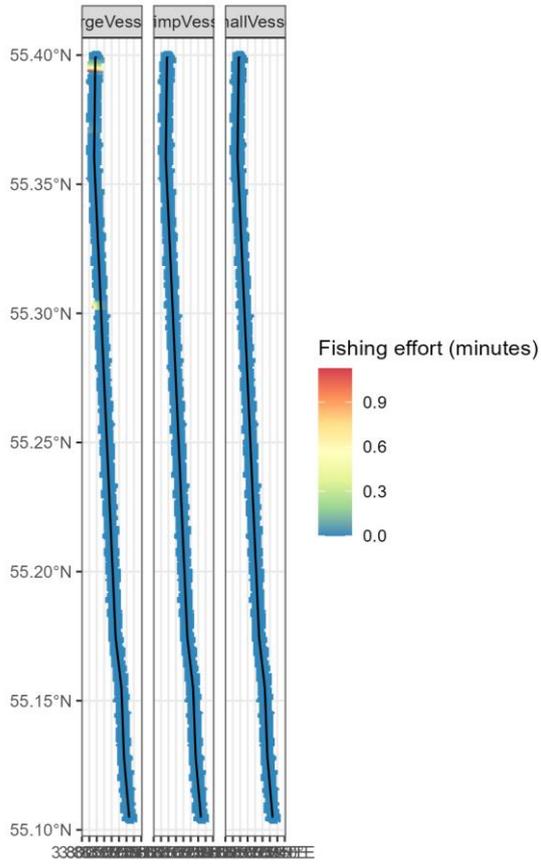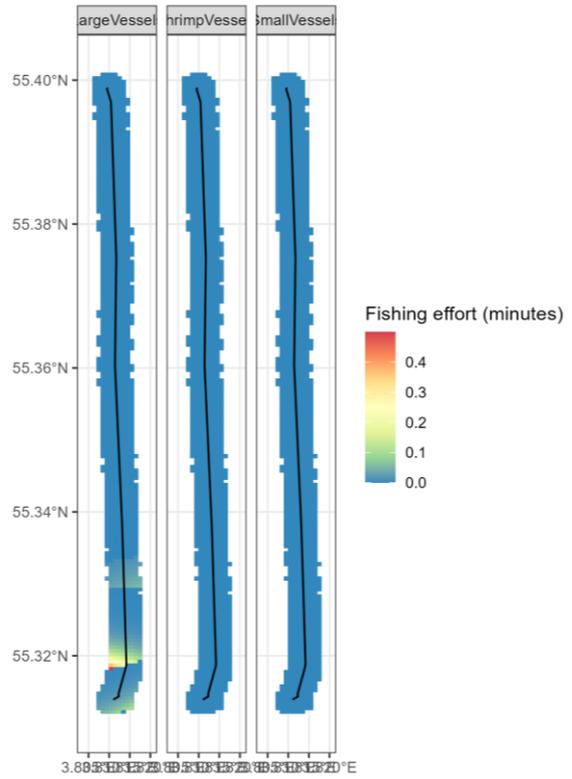
Figure 3. *Fishing intensity in minutes near each of the pipelines considered in the study, for Large vessels (left), Small vessels (middle) and shrimp vessels (right). U01-U09 are off the coast of IJmuiden, U10-U14 are in the Northern Dutch EEZ. The black oints represent ~10% of all VMS-pings near the pipelines. Note the differing values in the legends for each pipeline.*

Note that there is no fishing of shrimp vessels in the northern part of the Dutch EEZ.

Results indicate that most section of the Petrogas E&P pipelines were not fished in 2024, and that fishing intensity near most of the pipelines in 2024 was low to very low. The most southerly pipelines (U06b and U07) experience the greatest fishing intensity, with mainly shrimp vessels close to the coast and mainly large vessels further away from the coast (outside the 12NM zone). Long-term average fishing intensity of the Dutch fleet indicate a similar pattern with low fishing intensity of larger and small vessels in near the Dutch coastline at the latitude of the IJmuiden harbour as well as low fishing intensity in the northern part of the Dutch EEZ. Highest fishing intensity is visible close to shore due to high abundance of shrimp trawlers. These trawlers are however associated to have lighter gear compared to small beam trawlers. Consequences of the weight of the gear to the risk of damaging pipelines are not assessed in the present study.

5 Conclusions and recommendations

The results from this study show that the fishing activity in 2024 of the shrimp-trawl fleet are most relevant for the coastal pipelines (U06b), and that fishing activity of large beam trawlers is mainly relevant for the offshore pipelines. Though shrimp gears fish parts of the pipelines most intensively, from a risk perspective, these may be less important than beam trawlers, otter trawlers or seines, as they tow light gears over the seafloor. Fishing intensity at the pipelines seems to have reduced since 2022 (Van de Pol, 2023). This could be due to the large cessation in the Dutch beam trawl fleet in 2023.

No information is available on how much damage e.g. a small beam-trawl, a large beam-trawl or otter trawl gear would have on a pipeline although proxies for hydrodynamic drag have recently been derived. For this reason, all gears are treated similarly when expressing fishing effort indicators.

The indication of VMS pings in the figures, clearly show that 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 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.

References

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Van de Pol, L. (2023). *Fishing activity near Petrogas offshore pipelines, 2022*. (Report; No. C034/23A). Wageningen Marine Research. https://doi.org/10.18174/632381

# Justification

Report: C044/25
Project Number: 4316100406

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

Approved: T.C. Vallina
                   Researcher

Signature:
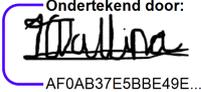
Ondertekend door:

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Date: 13 June 2025

Approved: C.J. Wiebinga, PhD
                   Business Manager Projects

Signature:
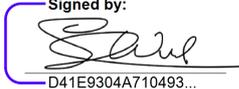
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Date: 13 June 2025

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