Ifremer
Système d'Informations Halieutiques

NOTE

# ALGOPESCA

# GEOLOCATION DATA PROCESSING ALGORITHM

## SUMMARY NOTE



**RBE/STH/LBH**

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# 1 PRINCIPLE

ALGOPESCA is a software package, produced and developed by Ifremer since 2005, whose primary objective is to reconstruct the fishing trips and fishing sequences[1] of geolocated vessels transmitting their geographical position (GPS), speed and heading at regular intervals. The second objective of ALGOPESCA is to estimate the fishing effort (in vessel fishing hours) for each vessel on a daily basis and to spatialise this effort according to different granularities (resolutions). The software also includes modules for extracting raw vessel positions and calculating stationary points at sea (to differentiate between moorings and new spots for landing catches).

[1] Within a fishing trip of a vessel, a new fishing sequence is calculated when there is a change of day and/or gear/mesh size/dimension. A fishing sequence can therefore aggregate different areas and/or different fishing operations for which fishing has been carried out within the same '*trip*day*gear*mesh size*dimension*' quintuple combination.

# 2 OPERATION

ALGOPESCA uses satellite geolocation data from:

- fishing vessels (operating under a French or foreign flag in waters under French jurisdiction) of more than 12 metres[2], which must be equipped with a vessel monitoring system (VMS) in accordance with (EU) Regulation No 404/2011, with a transmission frequency of one hour;

- fishing vessels equipped with mandatory VMS following local prefectural decrees (e.g. during scallop fishing campaigns in the Bay of Seine, for kelp harvester vessels in Brittany, etc.), with a transmission frequency between 15 minutes and one hour depending on the metier and/or sector;

- fishing vessels voluntarily equipped with Ifremer's RECOPESCA device, with a transmission frequency of between 1 and 15 minutes.

VMS data are transmitted daily by the *Centre National de Surveillance des Pêches* (CNSP; National Fisheries Monitoring Centre) to Ifremer's fisheries database 'Harmonie'. RECOPESCA data are transmitted directly to Harmonie as soon as the equipped vessel is within range of the Orange telephone network.

The ALGOPESCA software package is run at the end of each month, or even twice a month, to reconstruct the fishing trips and fishing sequences of the geolocated vessels.

[2] Before 2012, this was above 15 metres

# 3 DETERMINING THE ACTIVITY OF A GEOLOCATED VESSEL

To determine whether the vessel is stationary in a harbour, steaming or fishing, the main algorithm analyses the average speeds calculated between two successive positions along a straight trajectory (= a path), according to a set speed threshold (determined based on discussions with many fisheries professionals).

## 3.1 Vessel 'in a harbour'

A vessel will be systematically considered to be in a harbour in five cases:

- during the first and last path of a fishing trip;
- when one of the two positions of a path is transmitted within 2 nm of a mooring (reference list regularly updated)[3] with an average speed ≤ 0.25 knots;
- when one of the two positions of a path is transmitted in the vicinity of a harbour where the fishing activity of the geolocated vessels is unlikely (e.g. ad-hoc reference frame indicating that no vessel can fish within 3 nm of a Belgian harbour or within 0.5 nm of Concarneau);
- if it is over 9 metres: when either position is within the harbour area of its harbour of departure or return from the fishing trip, where it cannot theoretically fish (9- to 15-metre vessels = 0.5 nm radius around the harbour; 15- to 25- metre vessels and all vessels in foreign harbours = 2 nm; over 25 metres = 3 nm);
- if a vessel is longer than 25 metres: when one of the two positions of a path transmitted is within 2 nm of a harbour, even if that harbour is not the harbour of departure or return of the fishing trip.

## 3.2 Vessel 'fishing'

The decision rules used to qualify wether a vessel is fishing or not may be adapted according to the fleet or gear. Three decision trees are currently used in AlgoPesca :

- Netters model (minimum and maximum thresholds)
- Kelp harvester vessels model (single maximum threshold = 3 knots)
- Default model (single maximum thresold = 4.5 knots)

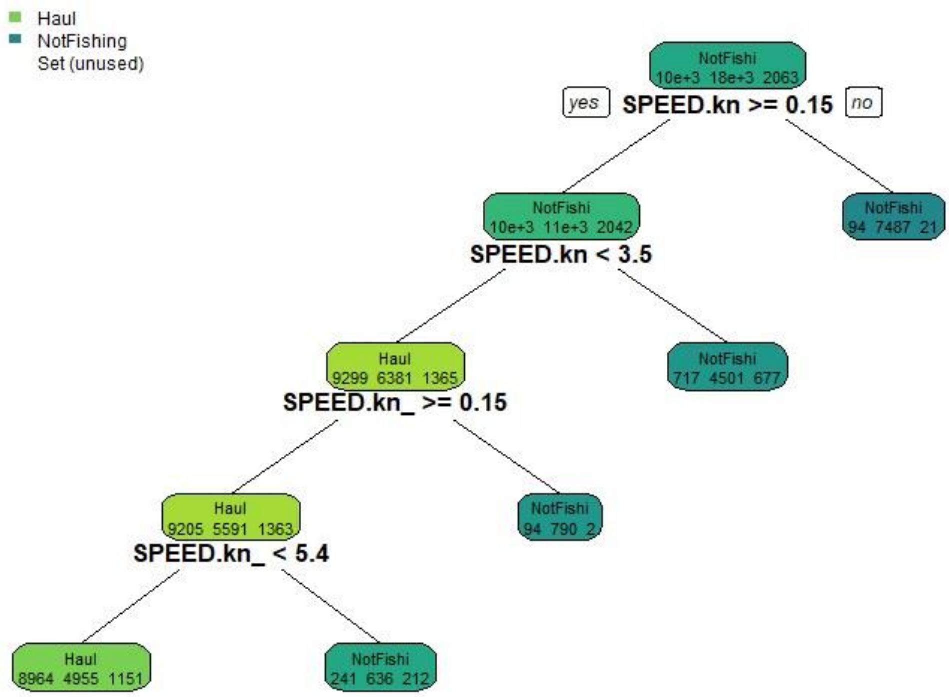
Other specific decision rules will be implemented in the future, subject to appropriate validation, bearing in mind that expert rules are not suitable for average speeds calculated on one-hour time steps.

The default and kelp harvester vessels rules are simple, since they use a single maximum fishing threshold :

[3] The analysis of stationary points at sea is carried out regularly (*at least* every quarter) to improve the 'harbours/moorings' reference list, which enables the software package to determine the harbour of departure and arrival.

- If the average fishing speed between two consecutive positions is less than or equal to 4.5 knots (3 knots for the kelp harvester vessels), the activity is set to « fishing »

The netters model is presented in the following decision tree :




In this figure, the thresholds shown in the decision tree are rounded to two decimal places. A netter is considered to be fishing between two positions Pn-1 (previous position) and Pn (current position) if its speed between Pn-1 and Pn remains greater than or equal to 0.1468863 knots and strictly less than 3.458803 knots, and if its speed between Pn and Pn+1 (next position) is greater than 0.1474532 knots and less than 5.434335 knot.

When a vessel is moving at low speed, particularly when entering or leaving a harbour, it should not be considered by the algorithm as fishing, as this could overestimate the fishing effort. This is why ALGOPESCA isolates the 'false fishing times' detected at the beginning and end of a fishing trip and instead considers them as periods of entry or exit from the harbour. These depend on the total duration of the fishing trip (Table 1).

| Duration of the fishing trip | Transit period considered at the start of the fishing trip | Transit period considered at the end of the fishing trip |
|---|---|---|
| 0–30 h | 1 h | 1 h |
| 30–65 h | 2 h | 2 h |
| 65–127 h | 2 h | 3 h |
| > 127 h | 3 h | 4 h |

*Table 1. List of harbour thresholds according to length classes of fishing trip*

Thus, at the beginning of the fishing trip, only vessel activity at a reduced speed after a fast path (transit to its fishing grounds) and at the end of the fishing trip before a fast path (transit to the return harbour) will be identified as fishing operations.

## 3.3 Vessel 'steaming'

A vessel is considered to be steaming if its speed is > 4.5 knots (3 knots for kelp harvester vessels).

## 3.4 Other cases

When GPS information is insufficient to qualify a vessel's activity (e.g., when the time interval between two positions is greater than 6 hours), the activity is said to be 'undetermined'. It should also be noted that the specific areas where French vessels are prohibited or authorised to fish in foreign waters and vice versa are taken into account by deletion or allocation of fishing time depending on the area (e.g., French vessels are prohibited from fishing within 0–12 nm of Scotland, with the exception of certain sectors when they are allowed within 6–12 nm) and that a position is considered anomalous if the average speed between this position and the previous one is greater than 40 knots.

# 4 RECONSTRUCTION OF GEOLOCATED FISHING TRIPS

## 4.1 Departure for a fishing trip

Departure is characterised by a vessel speed increasing from 0 knots to more than 0.5 knots over a period of just over one hour. The date and time of the first position in the period within 2 nm of a harbour is considered to be the start of the fishing trip. The starting harbour is the one closest to this first position (harbour reference list regularly updated ).

## 4.2 Return from a fishing trip

The return from a fishing trip is determined when a vessel has a very low average speed over a period of 2 hours from the time it is within 2 nm of a harbour (6 nm for African, Madagascan or Cypriot harbours, the Kerguelen Islands or Amsterdam Island). This requires both that the 'average speed 1', calculated between the first and last position during this 2-hour period without taking the trajectory into account, is less than 0.1 knots, and that the 'average speed 2', calculated taking the trajectory into account, is less than 0.3 knots (Figure 1).

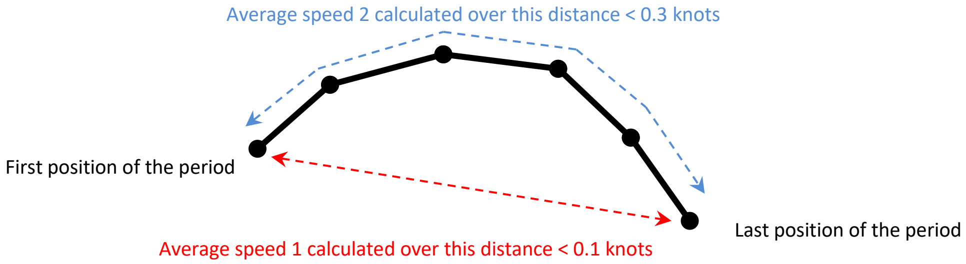



*Figure 1. Diagram of the speed calculation for detecting the end of a fishing trip*

The thresholds of this algorithm can be configured per vessel. This is currently only the case for kelp harvester vessels that work at stationary points and sometimes close to harbours. Thus, for these vessels, the search for the end of a fishing trip is carried out over a period of 4 hours instead of 2 hours and the two thresholds are set at 0.1 knots.

To compensate for the lack of GPS transmissions from certain VMS devices coupled to the vessel's engine, which would be cut when the engine was stopped, two additional algorithmic conditions are applied: the fishing trip is interrupted if two successive positions at sea are more than 10 hours apart or if they are more than 6 hours apart at a distance of less than 2 nautical miles from the nearest harbour.

In the case of 'lightening' landings, the duration of which may be of the same order of magnitude as the frequency of transmission of the VMS data (e.g. in the graph of speeds on the right-hand side of Figure 2, with the time on the x-axis and the average speed on the y-axis), the above algorithm cannot detect the returns to the harbour. Therefore, an *a posteriori* processing of the calculated fishing trips is performed in order to detect the characteristic behaviours of a vessel making a lightening landing, such as a stop in a harbour lasting less than 2.1 hours, with an average speed higher than 6 knots in the hours before and after this stop.

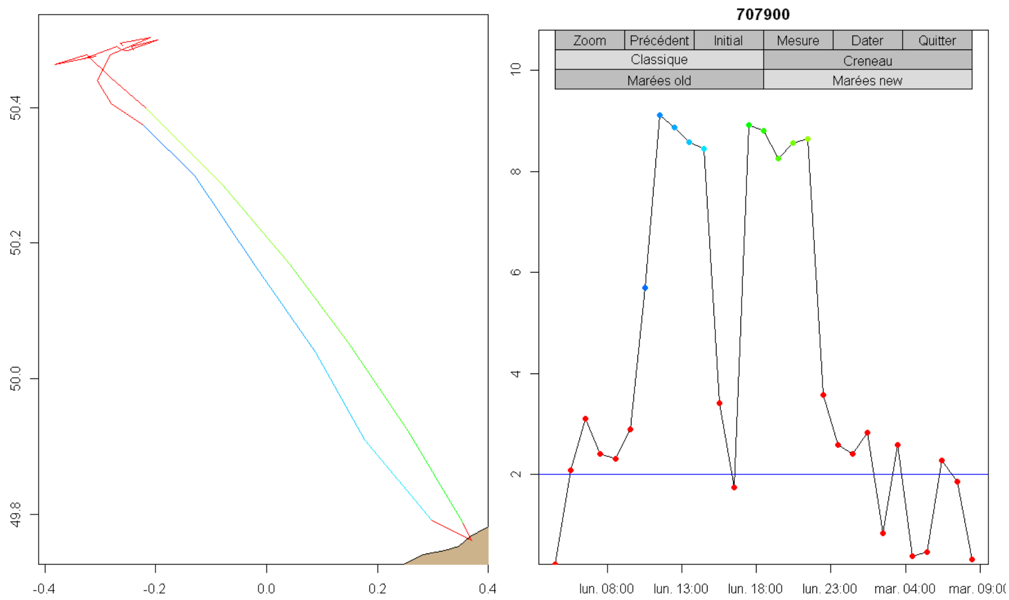



*Figure 2. Example of a 'lightening' landing seen through VMS data*

# 5 RECONSTRUCTION OF GEOLOCATED FISHING SEQUENCES

A geolocated fishing sequence takes into account the vessel's fishing trip, the day of activity and the fishing sector, the fishing gear deployed not being known (unlike a declared fishing sequence). Several types of geographical sector (parameterisable) can be considered. Currently the following two are used: an economic zone (e.g. 0–12 nm from the French shore) and an offshore sector (ranging from statistical rectangles to grids of 10' to 1' latitude and longitude). The calculation of the time spent in a sector (geographical polygon) corresponds to the distance between a position (p1 or p2) and the boundary of the sector (polygon) divided by the average speed between the start and finish positions (p1 & p2, see Figure 3 below).

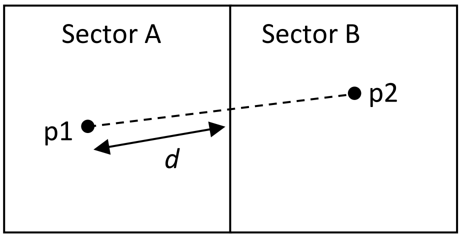



*Figure 3. Method of calculating the time a vessel spends in a given sector: fishing time in sector A = d / average speed between positions p1 and p2*

# 6 LIMITATIONS AND POSSIBLE IMPROVEMENTS

Various limitations to the processing of geolocation data can be seen in the current version of ALGOPESCA. The points that could be improved are of a technical nature or related to ALGOPESCA processing.

## 6.1 VMS data

Firstly, there may be problems with the reception and satellite coverage of GPS data or technical failures of VMS devices, resulting in missing position data.

Secondly, the current regulatory transmission frequency may lead to an underestimation (or even an overestimation in some cases) of a vessel's fishing activity based on its positions transmitted every hour. The example below (Figure 4) shows the difference in accuracy of the data according to the transmission frequency (RECOPESCA system: between 1 and 15 minutes and VMS: 60 minutes) for a kelp harvester vessel. In this case, the fishing time is underestimated by about 10% at a frequency of 60 minutes compared with a transmission frequency below 15 minutes.

For this reason, a higher transmission frequency for certain sub-fleets should be encouraged, as required,  in order to reconstruct the real activity of the vessels as faithfully as possible.

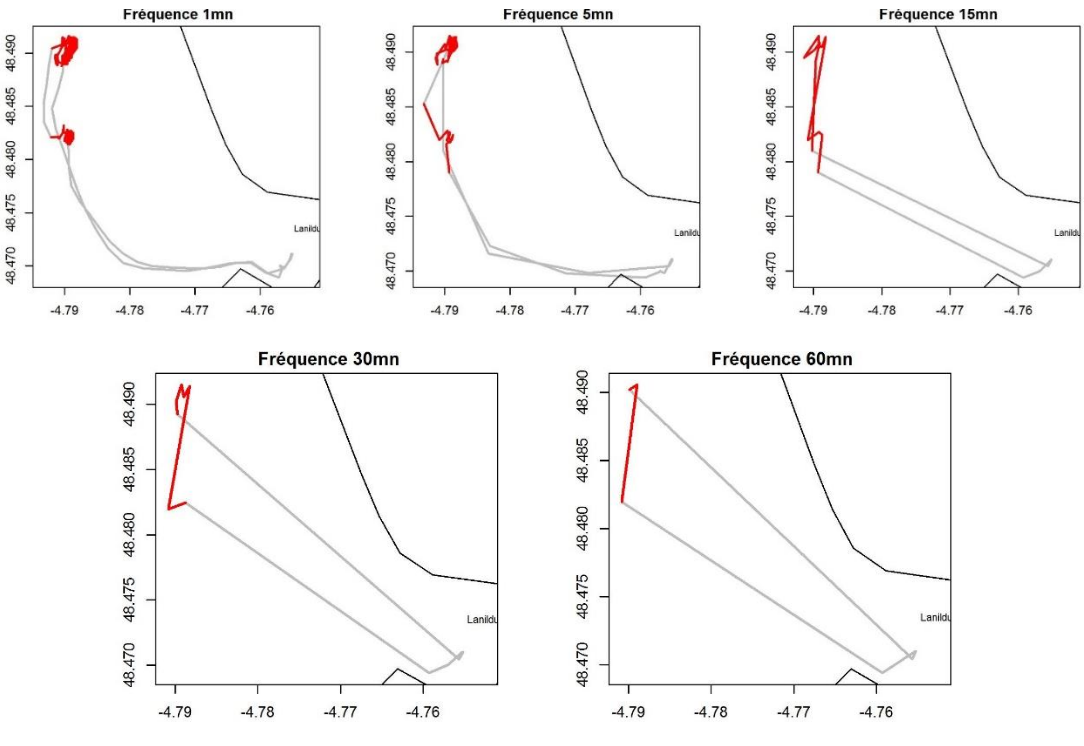



*Figure 4. Reconstruction of the trajectories and fishing operations (in red, 3 knot threshold) of a kelp harvester vessel using different transmission frequencies of GPS position*

## 6.2 The single speed threshold for all vessels

The average speed threshold of ≤ 4.5 knots currently used to define fishing activity would benefit from being adapted according to gears and metiers, or even according to geographical sectors depending on the type of gear used and local practices. It would be particularly beneficial to determine such adaptions based on input from fisheries professionals.

This generic threshold was established mainly on the basis of trawler data supplemented by interviews with fisheries professionals made by the fisheries information system (FIS) observers network. It is validated by the fine-grained RECOPESCA data and is well suited to most towed gears (bottom trawls, dredges, lines), but could be lowered for pots, nets and seines and increased for mixed trawls and pelagic trawls, as shown in the study by Weiss, 2020[4], who proposes a reference system for these thresholds by sub-fleet with a view to implementation in ALGOPESCA. The study by Berthou *et al.* (2020, in appendix) confirmed these initial results by analysing the impact of a uniform change in the average speed threshold on the estimation of the number of fishing trips, days and hours fished. Within sub-fleets, geographical effects were sometimes detected but not at the level of vessel size classes. The total effort in 2019 compared with what is currently calculated in ALGOPESCA would be impacted by this change, with an increase between 5% and 10% or a decrease between 7% and 14% depending on the sub-fleet.

It should be noted that the implementation of a lower threshold for average speed, which could be envisaged at first sight as a way to remove periods of non-fishing at reduced speed (e.g. a vessel that is hove to/holding station), was ruled out from the outset of the ALGOPESCA specification because of the short fishing operations of some metiers. Given the low frequency of acquisition of VMS geographical position data (one hour) and the fact that certain short fishing operations may be concentrated in restricted areas, a vessel may find itself in a position very close to the previous one after one hour's work. The lack of lower vessel speed threshold allows such fishing operations to be taken into account (see study by Berthou *et al.*, 2020, in appendix).

## 6.3 Consideration of gears/metiers

The SACROIS processing, which provides information on fishing gear, uses ALGOPESCA data to spatialise catches. It is therefore applied after the ALGOPESCA processing, which means that ALGOPESCA results do not benefit from the SACROIS data. A reciprocal loop could be considered so as to benefit from the information from both of these processes. The impact of this development on the software and the data is currently being evaluated.

A study is also underway to detect the metier based on the vessel's trajectory, but the low frequency of acquisition of the one-hour VMS data may limit its effective scope.

## 6.4 Estimating the real trajectory of the vessel

An estimate of the fishing activity of a vessel is based on the analysis of its average speed between two successive positions along a straight trajectory. The distance actually travelled and, hence, the real speed may thus be underestimated. There is then the risk of considering

[4] Weiss Jérôme (2020). Détermination des seuils de vitesse de pêche par flottille. https://archimer.ifremer.fr/doc/00661/77340/

all portions of the path below the 4.5 knot threshold, as 'fishing', and thus to overestimate the fishing effort.

The study of vessel trajectories could also, to some extent, identify more realistic trajectories and behaviours such as a vessel that is hove to (holding station) or broken down so that these situations are not confused with fishing operations.

## 6.5 The case of foreign vessels

Finally, in order to reconstruct the complete sea voyages of the vessels, all of the vessel position data must be available. Foreign vessels, for which the geographical position is systematically available only when they are in French waters, are therefore not processed by this software from the point of view of fishing trip reconstruction. It is generally impossible to exactly determine the start and end of the fishing trips of these vessels at their harbours of origin. However, the fishing effort estimates of these vessels are made using the same generic speed threshold of 4.5 knots. Vessel activity can also be approximated by the gear described in the European fleet file.

# 7 COMPARISON WITH THE METHOD PROVIDED BY ICES WGSFD

ALGOPESCA therefore differs from the method developed and used by the ICES Working Group on Spatial Fisheries Data (WGSFD), which collects and analyses spatial fisheries data to evaluate fishing effort, intensity and frequency in European waters.

To carry out these analyses, the WGSFD also uses the VMS data of the Member States, sometimes issued at the minimum frequency required in the European 'Control' regulation of once every two hours, and recommends using the methods developed in the framework of the call for tenders 'MARE/2008/10; Lot 2 - Development of tools for logbook and VMS data analysis', which led to the implementation of the R VMStools package (http://nielshintzen.github.io/vmstools/)[5].

In the most recent version of the code supplied by ICES, fishing activity is estimated by analysing instantaneous speed profiles. For each gear, a speed interval for which the vessel is considered to be fishing is established, either by expert judgement (choice of thresholds for each gear based on the speed histogram), or on the basis of decision rules already provided by the user. Fishing effort is then attributed to the ping position and not to a straight trajectory. In the latest version of the ICES code, catch allocation from logbooks is performed by default using a combination of Day X ICES Rectangle (declared in logbook) X Fishing trip X Vessel, these levels being downgraded when no overlapse is found.

In this code provided by ICES, many default settings can, however, be modified by an informed user.

It is planned in the medium term to compare the results that would be obtained via this code with those of ALGOPESCA, also considering the advantages/strong points of the latter detailed below. Given the many freedoms offered by the ICES WGSFD code to an informed user, the question of a comparison with the ALGOPESCA algorithm is relevant from the point of view of this allocation hypothesis (position or linear trajectory) and the consequence it may have on the spatialization of effort and catch, as well as the effect of some expert rules implemented in the algorithm.

[5] Hintzen, Niels; Bastardie, Francois; Beare, Douglas; Piet, Gerjan; Ulrich, Clara; Deporte, Nicolas; Egekvist, Josefine & Degel, Henrik (2012). VMStools: Open-source software for the processing, analysis and visualisation of fisheries logbook and VMS data. Fisheries Research. 115. 31-43. 10.1016/j.fishres.2011.11.007.

# 8 STRENGTHS OF THE ALGORITHM

ALGOPESCA has the advantage of offering the reconstruction of fishing trips and fishing sequences of geolocated French vessels. It also provides an estimate of fishing effort expressed in hours, including for foreign vessels working in French waters. Its implementation is operational on a monthly or twice-monthly basis[6] and allows data to be produced on different temporal and spatial scales.

Although fixed in the current configuration (except for kelp harvester vessels), the speed thresholds can be refined and incremented according to specific needs. The studies by Weiss (2020)[4] and Berthou *et al.* (2020, in appendix) have shown that the impact of their modification remains limited in the estimation of fishing effort and that the threshold currently set at 4.5 knots provides good quality spatialised daily fishing effort data.

The possibility of being able to spatialise the daily fishing effort estimated at different granularities is particularly interesting for, for example, estimating the vessels fishing and estimating the associated fishing effort over a specific period and fishing area (MPA, MRE, box, etc.).

Taking into account an average speed calculated between two VMS pings rather than the instantaneous speed associated with the ping also makes it possible to consolidate the reconstruction of geolocated fishing trips and the analysis of the state of the vessel (in a harbour, fishing or steaming).

The choice of reconstructing fishing trips with geolocated fishing sequences (rather than processing the data ping by ping, for example) is a real asset for subsequently reconciling these fishing trips reconstructed on the basis of geolocation (and in particular their very detailed spatial information) with fishing trips derived from declarative data (logbooks or declarative fishing forms) and/or fish sales note data via dedicated algorithms for calculating spatialised and adjusted effort and catch estimates by vessel, i.e. validated, consolidated and qualified data series on production and effort (e.g. 'SACROIS' software[7]).

Finally, the set of complementary devices and algorithms detailed above (e.g. to identify 'false' fishing times during harbour entry or exit), the experience acquired since 2005 and the monthly implementation of this software package also constitute an advantage for establishing the various calculations made. Furthermore, the well-established decision rules make it easy to understand the results of the applied algorithm and to explain them in a relatively simple way (which could be more difficult were more complex algorithms, e.g. neural networks, to be used).

[6] With calculation times adapted to a monthly or fortnightly operational implementation over one or two years and on all geolocated vessels.

[7] *https://sih.ifremer.fr/en/Debarquements-effort-de-peche/Sacrois*

ANNEX

# IMPACT OF A UNIFORM CHANGE IN THE AVERAGE SPEED THRESHOLD IN THE ESTIMATION OF THE NUMBER OF FISHING TRIPS, DAYS AND HOURS

**Patrick Berthou, Eric Bégot, Emilie Leblond**

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## INTRODUCTION

ALGOPESCA is a software package, produced and developed by Ifremer since 2005, whose primary objective is to reconstruct the fishing trips and fishing sequences[8] of geolocated vessels transmitting their geographical position (GPS), speed and heading at regular intervals. The second objective of ALGOPESCA is to estimate the fishing effort (in vessel fishing hours) for each vessel on a daily basis and to spatialise this effort according to different granularities (resolutions).

A speed threshold, which can be parameterised and is currently generic, is used for all vessels, regardless of their fishing practices, which are not known at the time of processing, to discriminate between the two states (whether a vessel is likely to be fishing or likely to be steaming). If the average speed of the vessel between two successive positions is ≤ 4.5 knots, it is considered to be fishing.

The objective of this document is to analyse the impact of variations in the average speed threshold on the estimates of the number of fishing trips, fishing days and vessel fishing hours. The results will be presented both as a whole and broken down by fishing sub-fleet and by the major types of activity.

## DATA USED

The geolocated positions from VMS, RECOPESCA and GEOLOX sources and databased in Harmonie were used in this study for all French vessels registered in the community fishing fleet register (CFR). The study period extended over the year 2019. For each geolocated vessel, all data sources were kept if the vessel was equipped with several devices. Information on sub-fleets (combination of metiers practiced during the year) and seaboard of registration was associated with these vessels.

[8] Within a fishing trip of a vessel, a new fishing sequence is calculated when there is a change of day and/or gear/mesh size/dimension. A fishing sequence can therefore aggregate different areas and/or different fishing operations for which fishing has been carried out within the same '*trip*day*gear*mesh size*dimension*' quintuple combination.

## PROCESSING OF GEOLOCATED POSITIONS

The ALGOPESCA software package was implemented by applying several generic speed thresholds to the geolocation dataset of each French vessel over the year 2019:

- 3N: maximum fishing threshold = 3 knots
- 3.5N: maximum fishing threshold = 3.5 knots
- 4N: maximum fishing threshold = 4 knots
- 4.5N: maximum fishing threshold = 4.5 knots (currently implemented)
- 5N: maximum fishing threshold = 5 knots
- 5.5N: maximum fishing threshold = 5.5 knots
- 6N: maximum fishing threshold = 6 knots

Another approach was to apply a minimum speed threshold of 1 or 2 knots:

- M1N: maximum fishing threshold = 4.5 knots and minimum threshold = 1 knot
- M2N: maximum fishing threshold = 4.5 knots and minimum threshold = 2 knots

## RESULTS

### *Impact of a change in speed threshold on all geolocated French vessels*

<u>Change in the speed threshold between 3 and 6 knots</u>

Between 4 and 6 knots, the variation in the speed threshold had very little effect on the estimates of the number of fishing trips (from -0.2 to 0.6%) or the number of fishing days (from -0.3% to 1.1%). The overall estimates of vessel fishing time varied little: from -4.6 to 5.5% (Table 1).

The 3-knot threshold, however, reduced the overall number of fishing trips and estimated fishing days by -2%. It also led to a decrease in the overall estimate of vessel fishing time by -29.4%. The 3.5-knot threshold would lead to a smaller reduction in the estimated number of fishing trips (-0.7%), a reduction in the number of fishing days by -0.9% and a reduction in vessel fishing time by -13.1%.

| | Change according to different average speed thresholds | | |
|---|---|---|---|
| | Number of fishing trips | Fishing days | Fishing time |
| threshold at 3 N | -2.0% | -2.0% | -29.4% |
| threshold at 3.5 N | -0.7% | -0.9% | -13.1% |
| threshold at 4 N | -0.2% | -0.3% | -4.6% |
| threshold at 4.5 N | 0.0% | 0.0% | 0.0% |
| threshold at 5 N | 0.2% | 0.4% | 2.0% |
| threshold at 5.5 N | 0.7% | 0.7% | 3.8% |
| threshold at 6 N | 0.6% | 1.1% | 5.5% |

*<u>Table 1</u>. Impact of speed thresholds for characterising probable fishing situations and route in the estimated number of fishing trips, fishing days and fishing time of French vessels in 2019*

Application of a lower speed threshold in addition to the 4.5 knot upper threshold

Applying a minimum speed threshold of 1 knot in addition to the maximum one of 4.5 knots would reduce the estimated number of fishing trips by -3.5%, the fishing days by -2.5% and the fishing time by -21.4% (Table 2).

By applying a minimum speed threshold of 2 knots in addition to the upper limit of 4.5 knots, the estimated number of trips would decrease by -11.4%, the number of fishing days by -9.1% and the fishing time by -42.4%.

| | **Change according to different minimum thresholds of average speed** | | |
|---|---|---|---|
| | **Number of fishing trips** | **Fishing days** | **Fishing time** |
| Limits 2 kn–4.5 kn | -11.4% | -9.1% | -42.4% |
| Limits 1 kn–4.5 kn | -3.5% | -2.5% | -21.4% |

*Table 2. Impact of using two speed thresholds to characterise the probable fishing situations and route on the estimates of the number of trips, fishing days and fishing hours of French vessels in 2019*

The implementation of a lower threshold on average speed, which at first sight could be envisaged as a means to eliminate periods of non-fishing at reduced speed (vessels hove to/holding station, etc.), was discarded at the start of the ALGOPESCA specification. This was done to take into account an effect of the low frequency of acquisition of VMS geographical position data (one hour). Depending on the metier, certain short fishing operations may be concentrated in small areas such that a vessel may then find itself in a position very close to its previous one after an hour's work [at the end of the appendix, some examples are given of comparative maps of geographical positions from VMS (measurement rate of 1 hour) and RECOPESCA (measurement rate varying from 1 to 15 minutes according to vessel)].

### *Impact of a change in speed threshold according to Ifremer sub-fleet and seaboard*

The impact of a change in the speed threshold for characterising fishing activity varies according to the sub-fleet and seaboard.

Impact on the estimation of the number of fishing trips

From the point of view of the estimated number of fishing trips (Table 3), the reduction in the average speed threshold to 4 knots had a very low impact for all sub-fleets (-0.2%). The change to 3 knots had a low impact (-2%), except for Mediterranean trawlers (-11.1%), bluefin tuna seine netters (-5%), purse seines (-4.9%), inshore metiers >3 nm in the Mediterranean and netters in the Channel (-4.1%).

A change to the 5.5 and 6 knot thresholds had very little overall effect on the estimated number of trips overall (+0.2 and +0.4%). However, these thresholds would increase the number of fishing trips by West Indian vessels operating offshore with lines by 17.6% and 19.9%, respectively. Increases in fishing trips would also be seen for Mediterranean bluefin tuna seine netters (6%) and Atlantic dredgers (6.4% and 8.1%).

| FLOTTILLE | Façade | Nombre de navires | % Marées 3N/4,5N | % Marées 3,5N/4,5N | % Marées 4N/4,5N | % Marées 4,5N/4,5N | % Marées 5N/4,5N | % Marées 5,5N/4,5N | % Marées 6N/4,5N |
|---|---|---|---|---|---|---|---|---|---|
| Chalutiers | Méditerranée | 62 | -11,1% | -2,3% | -0,2% | 0,0% | 0,0% | 0,0% | 0,1% |
| Chalutiers exclusifs | Atlantique | 241 | -0,4% | -0,2% | -0,1% | 0,0% | 0,1% | 0,2% | 0,3% |
| Chalutiers exclusifs | Mer du Nord - Manche | 82 | -0,4% | -0,3% | -0,2% | 0,0% | 0,1% | 0,3% | 0,5% |
| Chalutiers non exclusifs | Atlantique | 3 | -1,3% | -0,6% | 0,0% | 0,0% | 0,6% | 1,0% | 1,0% |
| Chalutiers non exclusifs | Mer du Nord - Manche | 251 | -0,4% | -0,3% | -0,1% | 0,0% | 0,1% | 0,2% | 0,3% |
| Chalutiers crevettiers | Guyane | 13 | -0,7% | -0,7% | -0,7% | 0,0% | 0,7% | 0,7% | 0,7% |
| Senneurs de fond | Atlantique | 17 | -0,1% | -0,1% | -0,1% | 0,0% | 0,1% | 0,1% | 0,1% |
| Senneurs de fond | Mer du Nord - Manche | 11 | -0,3% | -0,3% | -0,1% | 0,0% | 0,3% | 0,6% | 0,6% |
| Dragueurs | Atlantique | 3 | -1,7% | -0,5% | -0,2% | 0,0% | 3,0% | 6,4% | 8,1% |
| Dragueurs | Mer du Nord - Manche | 83 | -0,8% | -0,6% | -0,3% | 0,0% | 0,3% | 0,6% | 0,9% |
| Caseyeurs | Atlantique | 2 | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Caseyeurs | Mer du Nord - Manche | 29 | -0,4% | -0,2% | -0,1% | 0,0% | 0,2% | 0,5% | 0,5% |
| Caseyeurs Métiers de l'hameçon | Atlantique | 1 | -0,4% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Caseyeurs Métiers de l'hameçon | Mer du Nord - Manche | 2 | -0,5% | -0,5% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Fileyeurs | Atlantique | 79 | -1,0% | -0,5% | -0,2% | 0,0% | 0,3% | 0,5% | 0,7% |
| Fileyeurs | Mer du Nord - Manche | 49 | -4,1% | -2,3% | -0,9% | 0,0% | 0,9% | 1,6% | 2,0% |
| Fileyeurs Caseyeurs | Atlantique | 1 | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Fileyeurs Caseyeurs | Mer du Nord - Manche | 57 | -1,0% | -0,6% | -0,2% | 0,0% | 0,2% | 0,4% | 0,6% |
| Fileyeurs Métiers de l'hameçon | Atlantique | 4 | -2,7% | -1,5% | -1,2% | 0,0% | 0,2% | 0,7% | 1,2% |
| Fileyeurs Métiers de l'hameçon | Mer du Nord - Manche | 1 | -1,2% | 0,0% | 0,0% | 0,0% | 0,0% | 1,2% | 1,2% |
| Métiers de l'hameçon | Atlantique | 25 | -0,1% | -0,1% | -0,1% | 0,0% | 0,1% | 0,3% | 0,6% |
| Canneurs de Dakar | Atlantique | 1 | -1,7% | -1,7% | -1,7% | 0,0% | 0,0% | 0,0% | 0,0% |
| Divers métiers côtiers | Atlantique | 2 | -7,4% | -2,0% | -1,0% | 0,0% | 0,0% | 0,0% | 0,5% |
| Divers métiers côtiers | Mer du Nord - Manche | 6 | -1,1% | -0,9% | -0,6% | 0,0% | 0,0% | 0,4% | 0,4% |
| Métiers >3 milles | Méditerranée | 11 | -4,5% | -2,3% | -1,1% | 0,0% | 1,6% | 2,3% | 2,7% |
| Métiers côtiers | Méditerranée | 18 | -0,9% | -0,4% | -0,2% | 0,0% | 0,2% | 0,2% | 0,2% |
| Navires Côtiers | Antilles | 3 | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Navires Large | Antilles | 2 | -0,7% | -0,7% | 0,0% | 0,0% | 8,8% | 17,6% | 19,9% |
| Palangriers | Indien | 1 | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Palangriers à espadons | Indien | 19 | -0,8% | -0,3% | 0,0% | 0,0% | 0,0% | 0,0% | 0,0% |
| Bolincheurs | Atlantique | 27 | -5,0% | -2,9% | -1,2% | 0,0% | 0,9% | 1,5% | 2,0% |
| Senneurs à thons rouges | Méditerranée | 21 | -5,0% | -4,0% | -2,0% | 0,0% | 3,0% | 6,0% | 6,0% |
| Senneurs Tropicaux | | 22 | -1,6% | -1,6% | -0,3% | 0,0% | 0,3% | 1,3% | 1,6% |
| **Tous navires 2019** | | **1 182** | **-2,0%** | **-0,7%** | **-0,2%** | **0,0%** | **0,2%** | **0,4%** | **0,6%** |

*Table 3. Impact of the speed thresholds for characterising the probable fishing situations and route in the estimates of the number of fishing trips of French vessels in 2019 according to the sub-fleets and seas fished.*

## Impact on the estimation of the number of fishing days

A decrease in the speed threshold would have little effect on the estimated number of fishing days, except for Mediterranean trawlers (-11% for a threshold of 3 knots) (Table 4). An increase in the threshold has little effect on the estimate of fishing days except for West Indian vessels, bluefin tuna seine netters and Atlantic dredgers.

| FLOTTILLE | Façade | Nombre de navires | % Jours de pêche 3N/4,5N | % Jours de pêche 3,5N/4,5N | % Jours de pêche 4N/4,5N | % Jours de pêche 4,5N/4,5N | % Jours de pêche 5N/4,5N | % Jours de pêche 5,5N/4,5N | % Jours de pêche 6N/4,5N |
|---|---|---|---|---|---|---|---|---|---|
| Chalutiers | Méditerranée | 62 | -11% | -2% | 0% | 0% | 0% | 0% | 0% |
| Chalutiers exclusifs | Atlantique | 241 | -2% | -1% | 0% | 0% | 0% | 1% | 1% |
| Chalutiers exclusifs | Mer du Nord - Manche | 82 | -2% | -1% | 0% | 0% | 0% | 1% | 1% |
| Chalutiers non exclusifs | Atlantique | 3 | -1% | -1% | 0% | 0% | 1% | 1% | 1% |
| Chalutiers non exclusifs | Mer du Nord - Manche | 251 | -1% | 0% | 0% | 0% | 0% | 0% | 1% |
| Chalutiers crevettiers | Guyane | 13 | -1% | -1% | 0% | 0% | 1% | 2% | 2% |
| Senneurs de fond | Atlantique | 17 | -1% | 0% | 0% | 0% | 0% | 1% | 1% |
| Senneurs de fond | Mer du Nord - Manche | 11 | -1% | -1% | 0% | 0% | 1% | 2% | 3% |
| Dragueurs | Atlantique | 3 | -2% | 0% | 0% | 0% | 1% | 3% | 4% |
| Dragueurs | Mer du Nord - Manche | 83 | -1% | -1% | 0% | 0% | 0% | 1% | 1% |
| Caseyeurs | Atlantique | 2 | 0% | 0% | 0% | 0% | 0% | 1% | 2% |
| Caseyeurs | Mer du Nord - Manche | 29 | -1% | 0% | 0% | 0% | 0% | 1% | 1% |
| Caseyeurs Métiers de l'hameçon | Atlantique | 1 | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Caseyeurs Métiers de l'hameçon | Mer du Nord - Manche | 2 | -1% | -1% | 0% | 0% | 0% | 0% | 0% |
| Fileyeurs | Atlantique | 79 | -1% | -1% | 0% | 0% | 0% | 1% | 1% |
| Fileyeurs | Mer du Nord - Manche | 49 | -4% | -2% | -1% | 0% | 1% | 2% | 2% |
| Fileyeurs Caseyeurs | Atlantique | 1 | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Fileyeurs Caseyeurs | Mer du Nord - Manche | 57 | -1% | -1% | 0% | 0% | 0% | 0% | 1% |
| Fileyeurs Métiers de l'hameçon | Atlantique | 4 | -1% | -1% | -1% | 0% | 0% | 1% | 1% |
| Fileyeurs Métiers de l'hameçon | Mer du Nord - Manche | 1 | -1% | -1% | 0% | 0% | 0% | 1% | 1% |
| Métiers de l'hameçon | Atlantique | 25 | -1% | -1% | 0% | 0% | 0% | 1% | 1% |
| Canneurs de Dakar | Atlantique | 1 | -5% | -3% | -2% | 0% | 2% | 4% | 7% |
| Divers métiers côtiers | Atlantique | 2 | -7% | -2% | -1% | 0% | 0% | 0% | 1% |
| Divers métiers côtiers | Mer du Nord - Manche | 6 | -1% | -1% | 0% | 0% | 0% | 0% | 0% |
| Métiers >3 milles | Méditerranée | 11 | -4% | -2% | -1% | 0% | 1% | 2% | 2% |
| Métiers côtiers | Méditerranée | 18 | -2% | -1% | 0% | 0% | 0% | 0% | 0% |
| Navires Côtiers | Antilles | 3 | -7% | -6% | -5% | 0% | 5% | 7% | 12% |
| Navires Large | Antilles | 2 | -1% | -1% | 0% | 0% | 7% | 14% | 15% |
| Palangriers | Indien | 1 | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Palangriers à espadons | Indien | 19 | -1% | -1% | 0% | 0% | 1% | 1% | 3% |
| Bolincheurs | Atlantique | 27 | -5% | -3% | -1% | 0% | 1% | 2% | 2% |
| Senneurs à thons rouges | Méditerranée | 21 | -5% | -3% | -1% | 0% | 2% | 5% | 8% |
| Senneurs Tropicaux | | 22 | -1% | -1% | 0% | 0% | 0% | 1% | 1% |
| **Tous navires 2019** | | **1 182** | **-2%** | **-1%** | **0%** | **0%** | **0%** | **1%** | **1%** |

*Table 4. Impact of the speed thresholds used to characterise the probable fishing situations and route on the estimates of the number of fishing days of French vessels in 2019 according to the sub-fleets and seas fished.*

Impact on the estimation of the number of fishing hours

The change to a 4 knot threshold has little overall effect on vessel fishing time (-2%) except for Mediterranean trawlers (-42%) and swordfish long-liners in the Indian Ocean (-12%). These vessels appear to be fishing at higher speeds than the others (Table 5).

The change to a 3 knot threshold would mainly affect the fishing times of the trawler sub-fleets, particularly in the Mediterranean (-79%), but also in the Atlantic and Channel (around -40%), the bottom seiners (both in the Atlantic, -21%, and in the Channel, -22%), the purse seiners (-24%) and the swordfish long-liners (-30%). Estimates of vessel fishing time for the dredger, netter, pot vessels, troller and long-liner sub-fleets in the Channel and Atlantic were relatively less affected (-17% to -9%), suggesting that they work at lower speeds than, for example, the trawlers.

| FLOTTILLE | Façade | Nombre de navires | % Temps de pêche 3N/4,5N | % Temps de pêche 3,5N/4,5N | % Temps de pêche 4N/4,5N | % Temps de pêche 4,5N/4,5N | % Temps de pêche 5N/4,5N | % Temps de pêche 5,5N/4,5N | % Temps de pêche 6N/4,5N |
|---|---|---|---|---|---|---|---|---|---|
| Chalutiers | Méditerranée | 62 | -79% | -68% | -42% | 0% | 3% | 4% | 5% |
| Chalutiers exclusifs | Atlantique | 241 | -40% | -12% | -2% | 0% | 1% | 2% | 3% |
| Chalutiers exclusifs | Mer du Nord - Manche | 82 | -43% | -18% | -4% | 0% | 2% | 3% | 4% |
| Chalutiers non exclusifs | Atlantique | 3 | -38% | -7% | -1% | 0% | 1% | 2% | 4% |
| Chalutiers non exclusifs | Mer du Nord - Manche | 251 | -18% | -9% | -4% | 0% | 3% | 5% | 7% |
| Chalutiers crevettiers | Guyane | 13 | -18% | -7% | -2% | 0% | 2% | 4% | 6% |
| Senneurs de fond | Atlantique | 17 | -21% | -9% | -3% | 0% | 3% | 5% | 7% |
| Senneurs de fond | Mer du Nord - Manche | 11 | -22% | -11% | -4% | 0% | 3% | 5% | 6% |
| Dragueurs | Atlantique | 3 | -12% | -7% | -3% | 0% | 3% | 6% | 9% |
| Dragueurs | Mer du Nord - Manche | 83 | -17% | -9% | -4% | 0% | 3% | 5% | 8% |
| Caseyeurs | Atlantique | 2 | -12% | -6% | -3% | 0% | 1% | 2% | 3% |
| Caseyeurs | Mer du Nord - Manche | 29 | -13% | -8% | -3% | 0% | 3% | 6% | 8% |
| Caseyeurs Métiers de l'hameçon | Atlantique | 1 | -11% | -7% | -3% | 0% | 3% | 7% | 11% |
| Caseyeurs Métiers de l'hameçon | Mer du Nord - Manche | 2 | -12% | -8% | -3% | 0% | 3% | 6% | 9% |
| Fileyeurs | Atlantique | 79 | -7% | -4% | -2% | 0% | 2% | 3% | 5% |
| Fileyeurs | Mer du Nord - Manche | 49 | -14% | -9% | -4% | 0% | 4% | 7% | 10% |
| Fileyeurs Caseyeurs | Atlantique | 1 | -10% | -6% | -3% | 0% | 2% | 4% | 6% |
| Fileyeurs Caseyeurs | Mer du Nord - Manche | 57 | -12% | -7% | -3% | 0% | 3% | 6% | 9% |
| Fileyeurs Métiers de l'hameçon | Atlantique | 4 | -9% | -5% | -2% | 0% | 2% | 4% | 6% |
| Fileyeurs Métiers de l'hameçon | Mer du Nord - Manche | 1 | -9% | -6% | -3% | 0% | 1% | 1% | 2% |
| Métiers de l'hameçon | Atlantique | 25 | -8% | -5% | -2% | 0% | 2% | 4% | 6% |
| Canneurs de Dakar | Atlantique | 1 | -16% | -10% | -5% | 0% | 5% | 12% | 19% |
| Divers métiers côtiers | Atlantique | 2 | -27% | -17% | -7% | 0% | 5% | 8% | 10% |
| Divers métiers côtiers | Mer du Nord - Manche | 6 | -6% | -3% | -1% | 0% | 1% | 2% | 4% |
| Métiers >3 milles | Méditerranée | 11 | -19% | -11% | -6% | 0% | 7% | 11% | 15% |
| Métiers côtiers | Méditerranée | 18 | -6% | -4% | -2% | 0% | 1% | 2% | 2% |
| Navires Côtiers | Antilles | 3 | -8% | -5% | -3% | 0% | 5% | 11% | 17% |
| Navires Large | Antilles | 2 | -7% | -5% | -2% | 0% | 3% | 5% | 8% |
| Palangriers | Indien | 1 | -20% | -12% | -5% | 0% | 5% | 12% | 18% |
| Palangriers à espadons | Indien | 19 | -30% | -22% | -12% | 0% | 12% | 22% | 32% |
| Bolincheurs | Atlantique | 27 | -21% | -13% | -7% | 0% | 6% | 12% | 17% |
| Senneurs à thons rouges | Méditerranée | 21 | -14% | -10% | -5% | 0% | 6% | 11% | 18% |
| Senneurs Tropicaux | | 22 | -7% | -5% | -2% | 0% | 3% | 5% | 8% |
| **Tous navires 2019** | | **1 182** | **-29%** | **-13%** | **-5%** | **0%** | **2%** | **4%** | **6%** |

*Table 5. Impact of the speed thresholds used to characterise the probable fishing situations and route in the estimates of the number of fishing hours of French vessels in 2019 according to the sub-fleets and area of operation.*

There is also a more or less marked seaboard effect depending on the sub-fleet. For example, the fishing times of Mediterranean trawlers are more affected by a reduction in speed limits than those of Atlantic or Channel trawlers.

## CONCLUSIONS

Analysis of the impact of varying the average speed threshold between two successive positions (generally one hour in the most common case of VMS geographical position data), which is used to distinguish between two states (likely to be fishing or likely to be steaming) shows that variations in the threshold from that used until now (4.5 knots[9] ) have little overall impact on the estimates of the number of fishing trips, fishing days or fishing time of the vessel

This observation needs to be qualified according to the fishing gear, which is summarised here through the fishing sub-fleets defined according to the gear or combination of gears used over the year. For some gears, there are also variations according to the operating area.
This first approach also provides indications of possible changes in the threshold depending on the gear used.

[9] This compromise threshold was established in the mid-2000s, after a survey among fisheries professionals, on the basis of available data, mainly from vessels over 15 metres and mainly trawlers.

**Comparative maps of geographical positions from VMS and RECOPESCA for some fishing trips.**

Below are a few examples of fishing trip trajectory maps from vessels equipped with both the VMS (in blue) and RECOPESCA (in red) devices. The frequency of acquisition of geographical position data from the VMS is one hour, while that of the RECOPESCA beacons varies between 1 and 15 minutes depending on the vessel.

*Figure 1. Comparative mapping of the trajectories of an offshore trawler according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 15 min).*

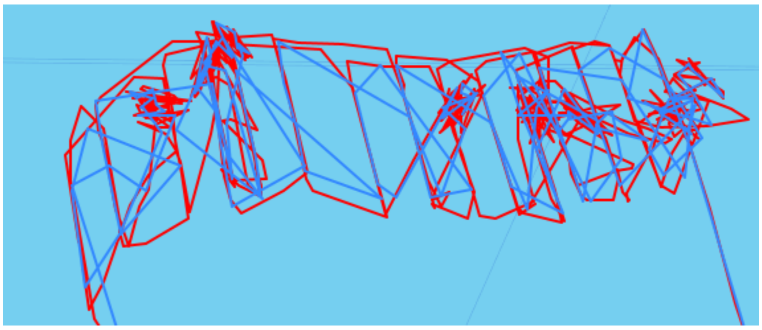
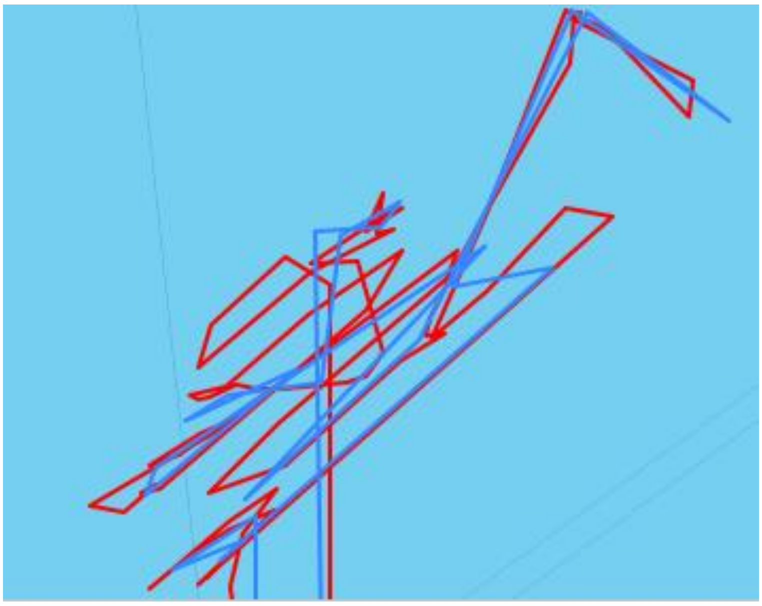
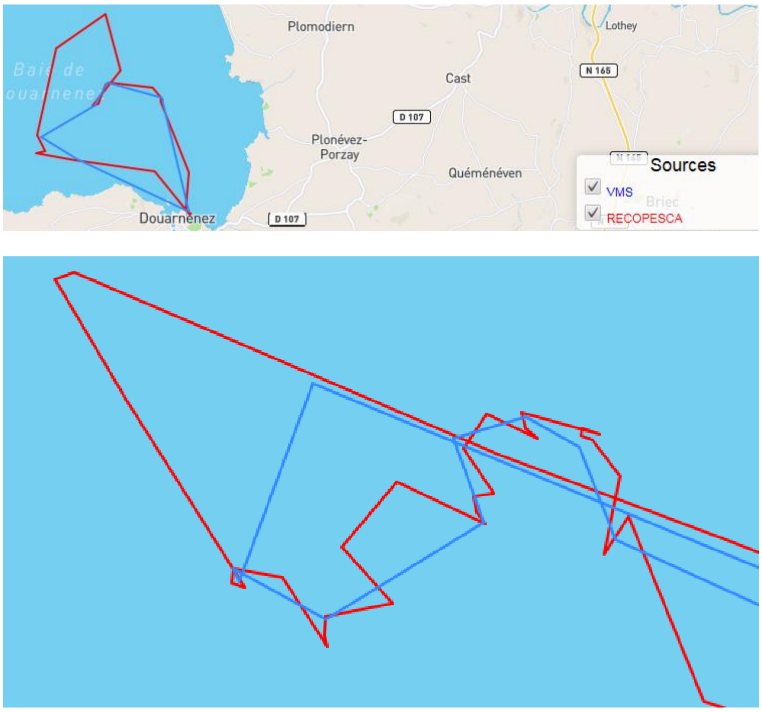


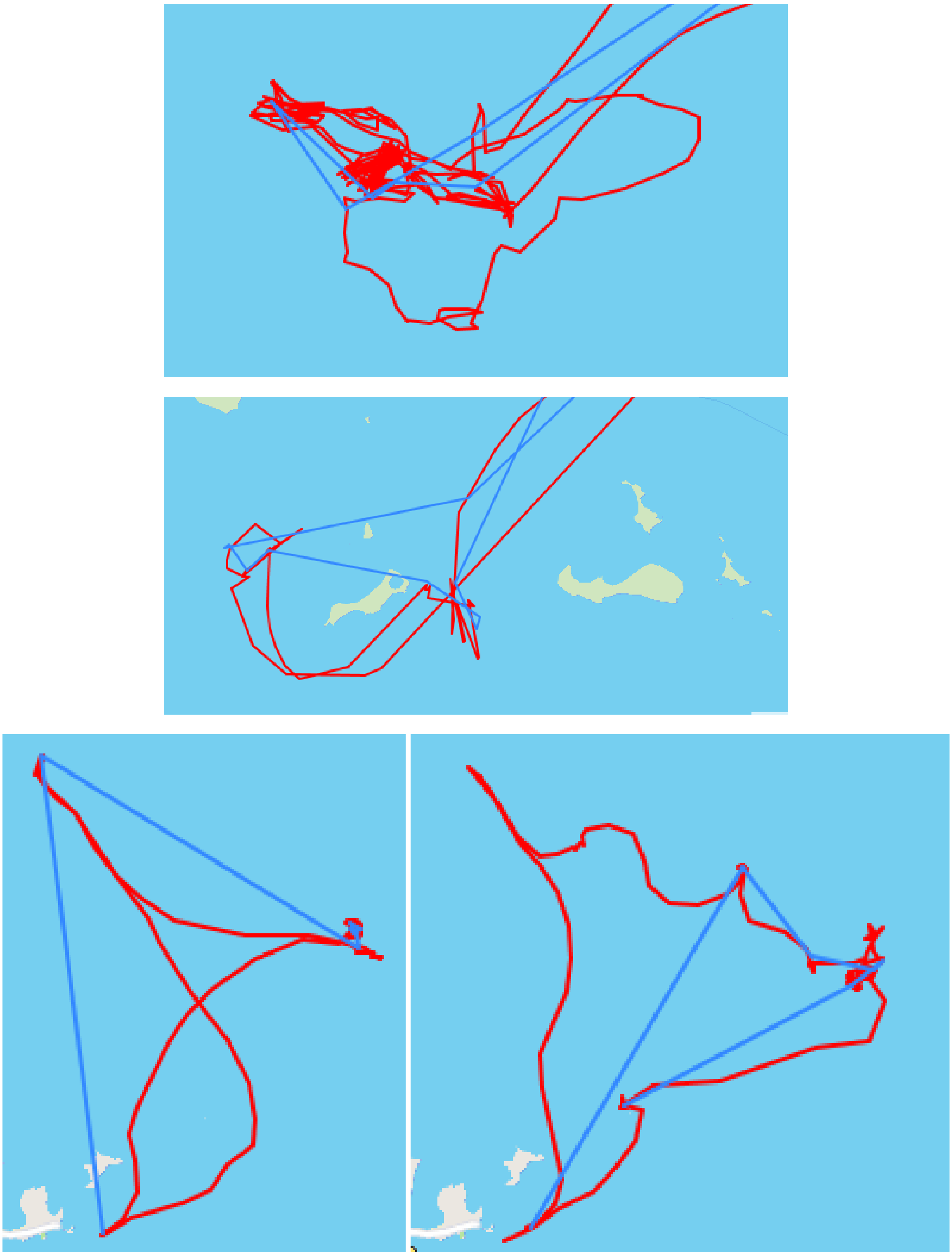
*Figure 2. Comparative mapping of the trajectories of a pot vessel according to VMS (in blue, measurement rate of 1 hour) and according to RECOPESCA (in red, measurement rate of 15 min).*



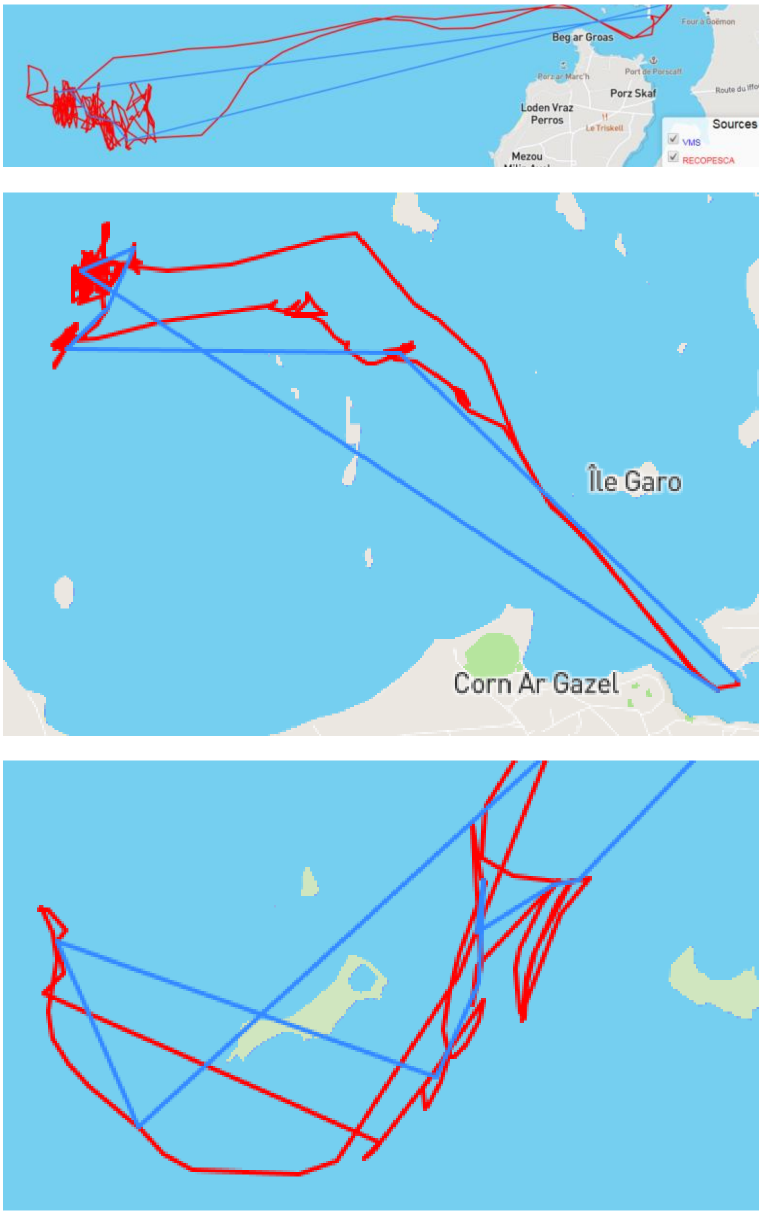
*<u>Figure 3</u>. Comparative mapping of the trajectories of a netter according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 15 min).*




*<u>Figure 4</u>. Comparative mapping of the trajectories of a purse seiner according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 15 min).*



*<u>Figure 5</u>. Comparative map of the trajectories of a kelp harvester vessel working with a scoubidou according to VMS (in blue, measurement rate of 1 hour) and according to RECOPESCA (in red, measurement rate of 1 min).*




<u>*Figure 6.*</u> *Comparative mapping of the trajectories of a* Laminaria hyperborea *(kelp) dredger according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 1 min).*

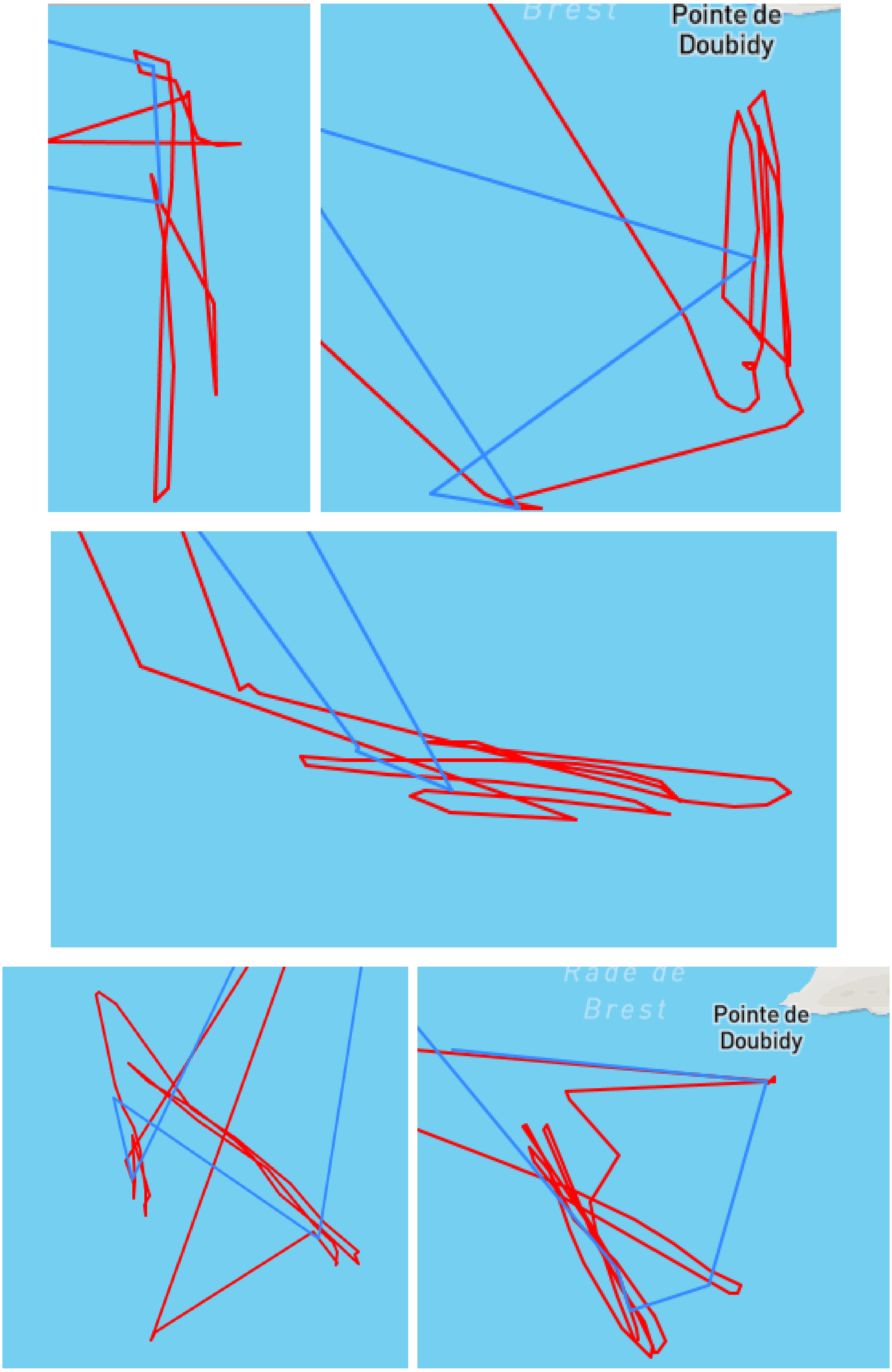



*Figure 7. Comparative mapping of the trajectories of a dredger according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 3 min).*

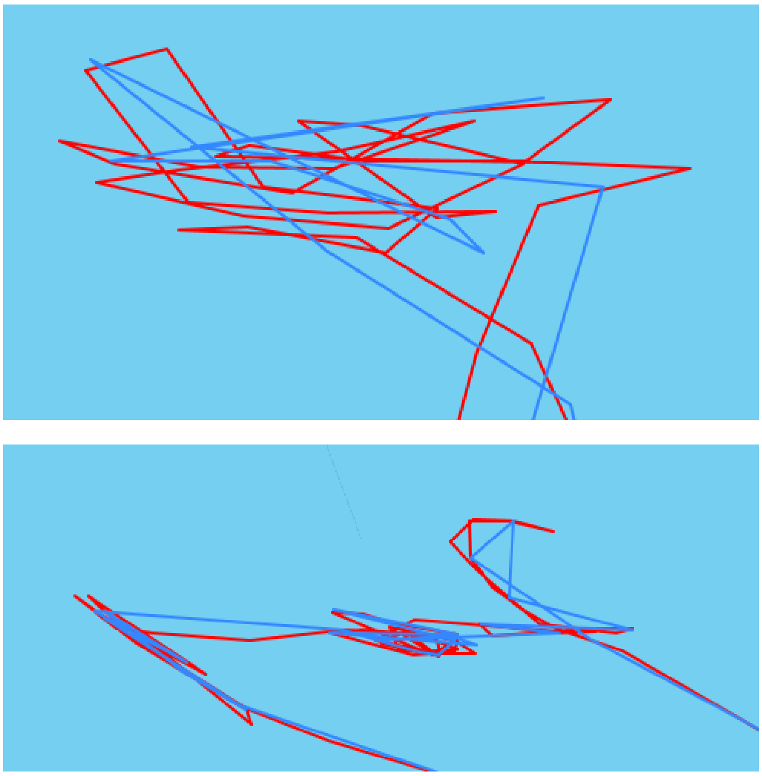


*Figure 8. Comparative mapping of the trajectories of a dredger according to VMS (in blue, measurement rate of 1 hour) and RECOPESCA (in red, measurement rate of 15 min).*

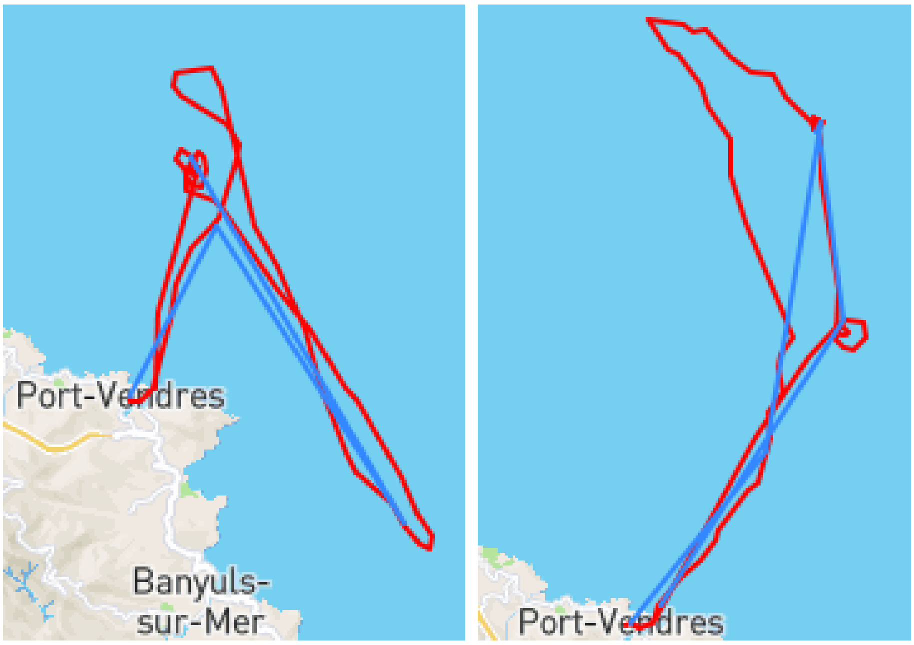



*Figure 9. Comparative mapping of the trajectories of a lampara seine netter according to VMS (in blue, measurement rate of 1 hour) and according to RECOPESCA (in red, measurement rate of 15 min).*