Fish-X

D4.2: Insight Platform v2.1 User Manual for Testing Users (including machine learning tool)

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Abstract	The deliverable 'Insight Platform v2.1 User Manual for User Testing (including machine learning tool)' is delivered in association with the live version v2.1 of the Insight Platform available at the following address: https://insight.groupcls.com The Insight Platform v2.1 constitutes the main deliverable D4.3 due by the project. The present document gives an instant and static view of the Insight Platform opened to public on 28 February 2025. Although the web site is designed to offer simple and self-explanatory functions so new users can play and discover the various tools, it is advisable to read the User Manual for a better understanding of the concepts used in Insight, particularly the Vessel Presence aggregations (already delivered in v1) and the new Fishing Effort aggregations. The main innovation in the Insight v2.1 version is its embedded analysis of fishing vessels' trajectories. This is a major improvement, complementing the previous indicator of presence of vessels with an indicator of presence of fishing gear (nets, traps) expressed as apparent fishing effort, a concept more useful for fisheries management. The analysis of vessels' trajectories is made using machine learning applied to records of past vessels trajectories in two steps: 1) Automatic estimation of the most probable fishing gear used during the fishing trip (assuming the small-scale fishing vessels may change their fishing gear from one trip to another). 2) Automatic detection of the start and the end of the fishing activity, with fishing gear active in water. In the appendixes, more explanations are given to clarify some specific processes such as the aggregation of vessels and time spent per zone. A new Insight Platform version v2.2 will be released in April 2025 and this User Manual will be updated, to include new

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	functions, in particular the maps displaying electronic logbook reports and new fishing gears will be detected by AI. The manual and the website will be used together by the Testing Users (e.g. members of the consortium and voluntary users) to navigate between the functions available and verify that the functional specifications expressed in the document D4.1 'Insight Platform Functional Definition and Use Case Document' have been supported.

Document history

Version	Issue Date	Stage	Description	Contributors (Name/affiliation)
1.0	27.02.2025	Draft	Initial version for ECAS	Jean-Pierre Cauzac (CLS) Theo Saccareau (CLS)
2.0	27.02.2025	Draft	Draft Review	Jana Stünkel (TMT) Ankith Kumar (TMT) Andrew Thorsen (TMT) Seamus Bonner (IIMRO) Hrvoje Čeprnja (WWF Adria) Raquel Pereira (Sciaena) Joana Oliveira (WWF Portugal) Sylvie Giraud (CLS)
3.0	28.02.2025	Final Version	Final Version to be submitted to ECAS	Jean-Pierre Cauzac (CLS) Theo Saccareau (CLS) Jana Stünkel (TMT)

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Table of Content

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Acronyms and abbreviations

Abbreviation	Meaning
AI	Artificial Intelligence
AIS	Automatic Identification System
AWS	Amazon Web Services (cloud hosting Insight)
CFR	EU Common Fleet Register
DG Mare	Directorate-General Maritime Affairs and Fisheries
EEZ	Exclusive Economic Zone
EMODnet	European Marine Observation and Data Network
ERS	Electronic Reporting System
EU	European Union
FAO	Food and Agriculture Organization
FMC	Fisheries Monitoring Center
FRA	Fisheries Restricted Area
GDPR	General Data Protection Regulation (EU) 2016/679
GFCM	General Fisheries Commission for the Mediterranean and Black Sea
GUI	Graphical User Interface
ICES	International Council for the Exploration of the Sea
OSM	Open Street Map
MPA	Marine Protected Area
SSF	Small-Scale Fisheries
UTC	Coordinated Universal Time
UX	User Experience
TID	Terminal Identifier (unique identifier of NEMO)
VMS	Vessel Monitoring System
WGS 84	World Geodetic System 1984 (used by GNSS to determine a position)

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List of Figures

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Executive Summary

Definition of the deliverables D4.3:

The main deliverable D4.3 is the live Insight Platform v2.1 available directly from the home page of the Fish-X web site. This present deliverable 'Insight Platform v2 User Manual for user testing (including machine learning tool)' is delivered in association with Insight.

Access to the Insight Platform here: https://fish-x.eu/ and click in the pop-up window, or at the following address by CLS:

https://insight.groupcls.com

Changes of Insight v2.1 (February 2025) versus Insight v1 (November 2024):

The live Insight Platform v2.1 constitutes the main deliverable D4.3 due by the project. CLS started the live platform development with a collection of users' needs provided by consortium partners (in particular WWF and Sciaena representing Mediterranean and Atlantic SSF) at the end of 2022. This specification deliverable D4.1 is available to the public. In June 2024, IIMRO joined the project and brought some requirements for the Irish Offshore Island's SSF monitoring.

The types of data represented in the Insight Platform v2.1 are the following:

- VMS presence (in number of vessels)
- VMS presence (in cumulated hours)
- *New*: Fishing Effort estimate based on machine learning and artificial intelligence, represented in form of new density maps. The Fishing Effort is based on fishing gear characteristic (e.g. gillnet length) multiplied by the duration of use of the gear.
- *New*: Three types of fishing gears are detected by the AI:
    - Passive gears (e.g. set gillnet, traps and pots)
    - Purse seine
    - Pole & lines
- *New* dashboards showing the fishing effort per type of fishing gear, with filtering options (filter by zone).
- *New* colour code for the density maps to appear more intuitive (darker: more vessels or more hours) and a *new* dynamic colour scale.

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Soon to come in the next version Insight v2.2:

In April 2025, Insight will be upgraded to a second version Insight Platform v2.2 with added functions:

- Additional fishing gears will be detected by the AI (conditional to the training data sets presently under analysis) such as dredges used for scallop fishing.
- Density maps to display where electronic logbooks (Electronic Reporting System or ERS) have been reported by fishers. Presently in the EU, the electronic logbook is a mandatory requirement for vessels above 12 meters in length, and the new control regulation will progressively implement this electronic logbook for vessels above 10 meters, with a report sent when returning to port and before landing of catch.

Audience – End Users:

The present document is a User Manual associated with the Insight Platform v2 as of February 2025. It aims to give simple instructions to a non-specialised public which has basic expertise in web applications, mapping tools, and fisheries. The appendices provide more explanations to clarify some specific terms and processes.

The Insight platform v2.1 aims to provide a wide audience with access to fisheries monitoring datasets collected throughout the project through small-scale fisher volunteer participating in the project's use cases. The website displays several fishing indicators (density maps of vessels number, vessels presence in hours, or fishing effort, KPIs, etc.) for small-scale fisheries. The audience following the Fish-X project consists of fisher representatives, government officers, civil society and scientists. This group is the first potential target audience of the platform. In addition, Insight is designed to allow other audiences (e.g. professional organisations of SSF fishers, MPA managers, NGOs, offshore wind park operators, seafood buyers) with legitimate interest to collect fisheries activities, to contribute by providing their own data sets. This offers an opportunity for ongoing projects at local or regional scale to display their activities on the portal and gain visibility.

Data Sets used as source of information:

In the present version, Insight v2.1 is fed with vessel positioning data collected during the Fish-X project with volunteer small-scale fishers in Portugal, Croatia, and Ireland. These fishers agreed to have the vessel fitted with a Vessel Monitoring System (VMS) device called NEMO. The VMS data feed starts in August 2024. The concept of Insight allows interfacing

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more types of data sets for vessel positioning or for electronic logbooks. Generic interface formats are described in public Fish-X deliverable D4.1.

The digital data sets displayed in the Insight Platform v2.1 are collected from the VMS devices. They represent the position of the fishing vessels collected with an interval of every 3 minutes, to provide precise tracking and detection of the fishing activity. The VMS device also transmits the instantaneous speed and heading of the vessel, the instantaneous speed is used for detection of vessels classified as active or in port.

In the next Insight Platform v2.2, additional information representing the place of transmission of the electronic logbook will be displayed in density maps. The density map will represent the number of logbooks reported per day per statistical square, not the quantities of captures, while this information could also possibly be represented as density maps.

About personal data protection:

The development of Insight is made by CLS in parallel with the development of a new generation of Fisheries Monitoring Center (FMC) and unified Electronic Reporting Systems (ERS) applications. Insight reflects the intention not to expose individual activities (e.g. vessels' tracks, locations in ports) which could lead to the identification of individual fishers. As the protection of fishers' individual and professional data was one of the major concerns expressed at the inception of the project, the individual vessel tracks are not displayed. Instead, they are converted into times of presence and aggregated into **density maps** showing statistical squares. By a convention commonly used in statistics, the presences are not displayed when fewer than 3 different vessels are in the statistical square, to protect the privacy of fishers. These statistical squares disappear when there are fewer than three vessels present in the area.

The data process is supervised by ethics advisers. The data entering into the Insight Platform servers have been previously anonymised, so it is not possible to access to the vessels identity by hacking the Insight Platform servers. In a separate application, CLS, as operator of the VMS service associated with the NEMO devices, manages a correspondence list between fishers and vessels IDs and the NEMO terminal identifiers (TID), as each individual NEMO has a unique TID.

All fishers who have accepted to take a NEMO VMS device onboard for the Fish-X project have signed a letter of consent which includes their agreement to contribute for populating Insight

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as a statistic tool. In parallel, they were given access to another portal called FishWeb, where they could see their own individual vessel tracks in real-time, for their own use.

The processing of data in CLS and on the AWS cloud complies with the EU GDPR regulation, and it has been reviewed by the project's ethics advisors.

Fish-X project funding:

The Fish-X project is co-funded by the European Commission Horizon Europe Programme (agreement no.: 101060879). The Fish-X project includes the development and operation of the Insight Platform and the Data Space environment to support the digital transition of Small-Scale Fisheries.

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1. Start Page

The Insight Platform is openly accessible to anyone and does not require any login or password. To do that: go to the Fish-X web site (www.fish-x.eu) and click in the green pop-up window or the button in the top right menu.

This user manual is available for download as a PDF in the pop-up window.

The Fish-X Goals & Outcomes menu gives more context to the project deliverables.

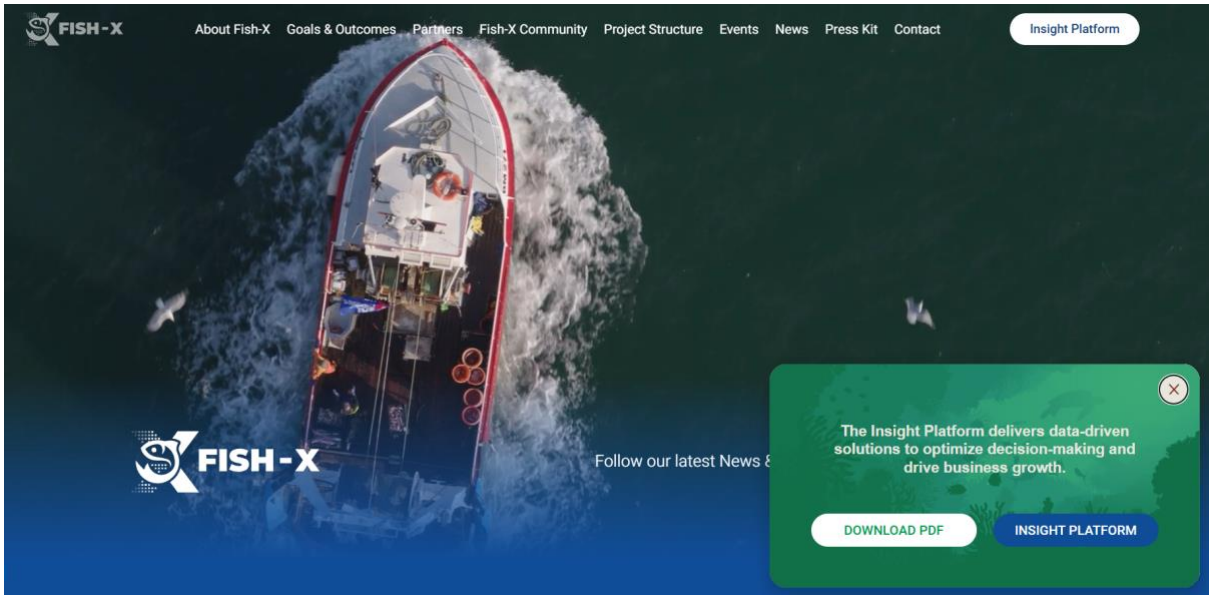

Figure 1 – Fish-X web site with access to Insight and to the PDF User Manual

You can also access to the Insight Platform with the following link:

https://insight.groupcls.com

2. Map Display

2.1 Buttons

By default, Insight starts with the map display in the entire globe projection, and the buttons in the right menu are used to zoom in to a specific area. Moving the map (panning) is made by clicking on the map and dragging the pointer.

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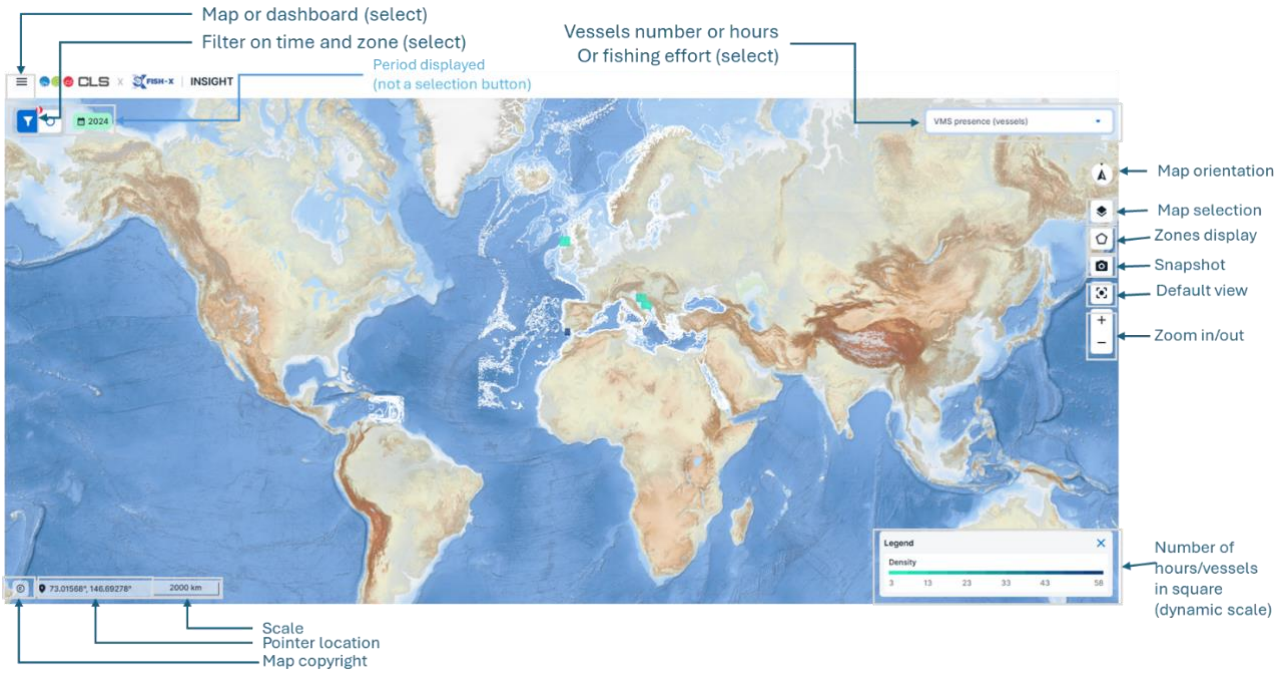

Figure 2 – Main map view

There are some buttons surrounding the main map display:

- **Buttons on the right side** relate to the map view:
    - Map orientation (in case the map is rotating)
    - Map selection by layer management, with two types of maps available
    - Zone display, to display one or several layers of zones on top of the map
    - Snapshot to download a .jpg view
    - Default view to return to the global map
    - Zoom in and out (zooming is also possible using the mouse wheel)

- **Buttons on the top left side** are used to select:
    - The display format (map or dashboard)
    - The time period of the data sets
    - The zones where data are displayed

- **Buttons on the top right side** refer to the selection of data sets to be displayed: number of vessels, number of hours, or fishing effort by statistical square

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This manual will give you a quick tour of their functions, it is proposed to use them in the following sequence of this manual, starting with the map display.

2.2 Select the Map

In the right menu bar, click the Map Layer button, two types of maps are available:

- The EMODnet Bathymetry map is made available by the European Commission DG Mare. It displays the surface and sea floor relief. Over the Atlantic and Mediterranean regions, the EMODnet map includes a layer of bathymetric lines (isobaths) [1]. This type of map is of interest to understand in which water depths the vessels are fishing.
- The Open Street Map provides more map details of interest for the coastal context: the villages, cities, roads etc are indicated.

Figure 3 – Map layer with EMODnet bathymetry

When zooming on the lines their depth value appears. The following values are displayed: 50|100|200|500|1000|2000|5000|7000 meters depth.

[1] https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/4f7ab468-f4b9-4c2c-8d3b-49a375cf9964

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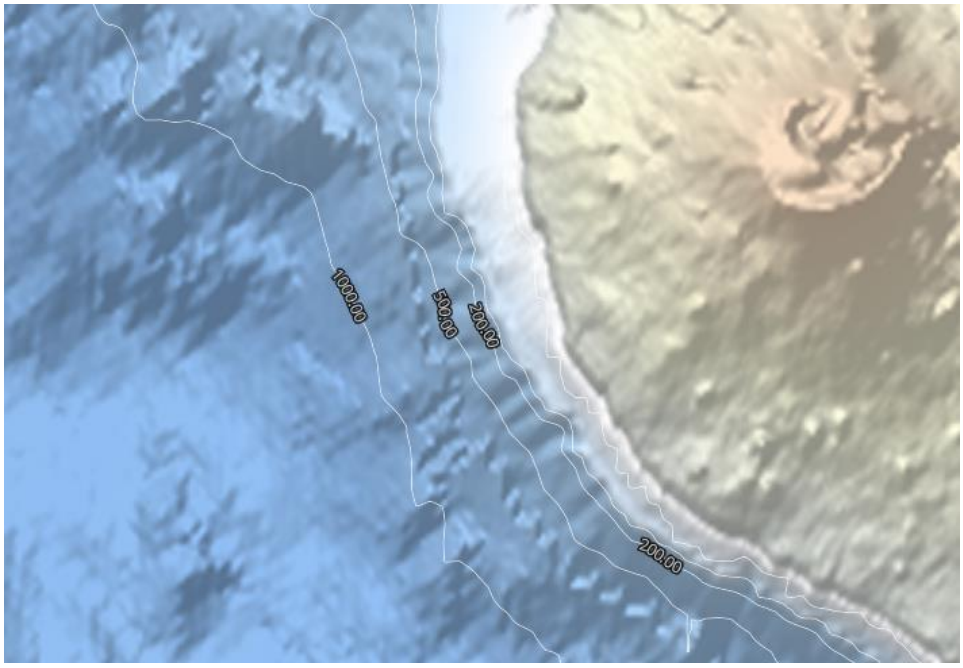

Figure 4 – Map layer with EMODnet bathymetry – Isobaths displayed when zooming

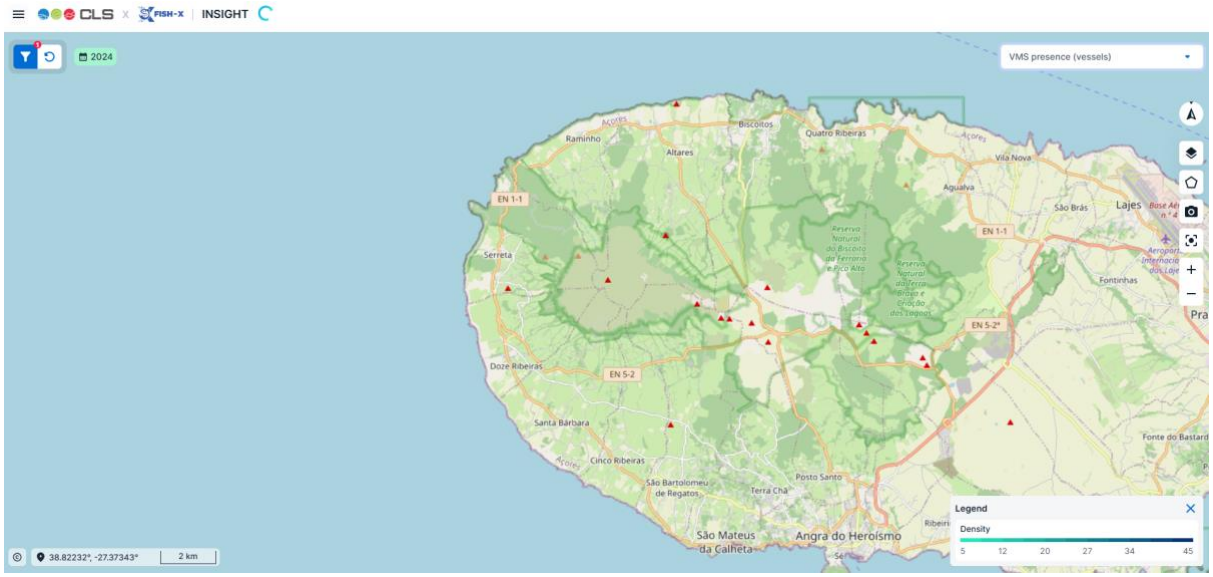

Figure 5 – Map layer with Open Street Map

2.3 Select Time Period

In the map display, it is necessary to define for which period of time the data should be displayed. There are three choices:

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- A day
- A month (cumulating all days in the month). Data was acquired since August 2024.
- A year (cumulating all months at the end of the year). Since data collection started in 2024, only 2024 is available as a cumulated year.

Click the funnel button (top left) and a window opens which allows selecting a day or a month to be displayed.

For selection of a month of data, proceed as follows:

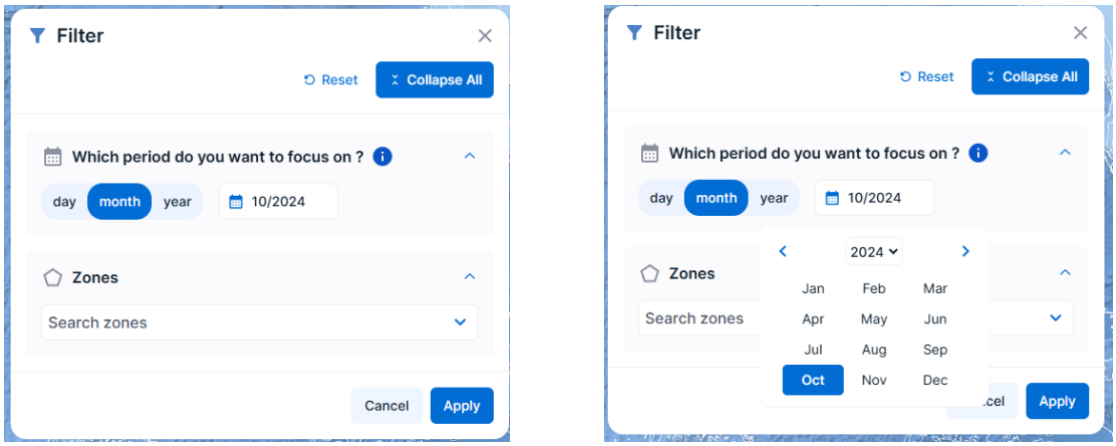

Figure 6 – Time period: month selection

- Click on the month button (Figure 6, left)
- Click on the calendar to choose which month will be displayed until the current month minus one month (Figure 6, right)
- Apply
- The map immediately displays the fishing vessels presence

For selection of a day of data, follow the same process:

- Click first on the day button (Figure 7, left)
- Click on the calendar to choose which day will be displayed (Figure 7 7, right)
- Apply
- The map immediately displays the fishing vessels presence

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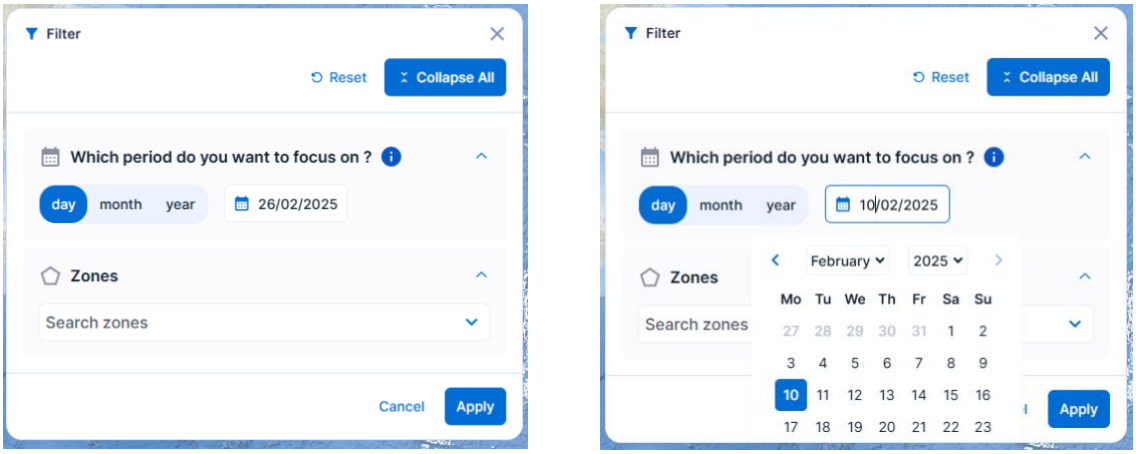


Figure 7 – Time period: day selection

Note:

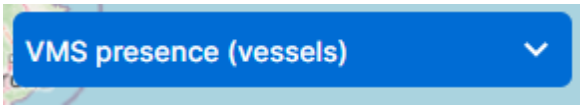
The Insight Platform does not display real-time data by design, as it is not made for control purposes. Each day, the statistics are computed for the current day minus two days. For instance, on the 14th of October, the most recent daily statistics are for the 12th of October.

The monthly statistics are produced after the end of month, plus 2 days. So, statistics for October will be available on the 3rd of November.

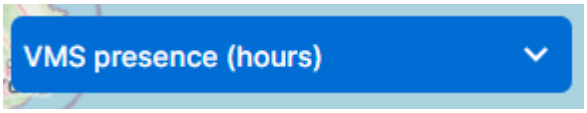
3. Vessel Presence Statistics

3.1 Statistical Squares

The concept of the Insight Platform is to represent maps with density indicators, either expressed in number of vessels, or number of hours of presence (presence does not mean fishing), or fishing effort detailed in the Section 4. These indicators are selected in the upper right part of the screen. After the time period has been selected, the results immediately appear on the map as statistical squares.



It counts the number of vessels present during the period in each square



It counts the number of hours of presence of these same vessels

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The size of statistical squares varies with the zoom level. In large views with low zoom level, the squares cover larger areas, then aggregate more vessels or presence time. When zooming in, each square progressively splits into smaller squares (division by 2 in height and width) to give results with a better resolution.

Zoom level	Size in degree
1	1.6°
2	0.8°
3	0.4°
4	0.2°
5	0.1°
6	0.05°
7	0.025°

Refer to the section 8 Appendix A if there is any interest to convert the statistical squares in kilometres.

Refer to the section 9 Appendix B to understand how the time spent in squares is calculated.

3.2 Densities Represented with Dynamic Colour Scales

To optimise the contrast, the densities of vessel presence (in green/blue) and of fishing effort (in pink) are represented using a dynamic colour scale. This means that the colours are adapted to the minimal (with lightest colour shade) and maximal values (with darker colour shade) to be represented. Should the minimal value in a statistical square be 3 vessels or 20 vessels, it will be represented by the same shade of light colour. A given shade of colour does not represent an absolute value.

This can be observed when browsing over the map of Europe. The colour palette for vessel densities goes up to 52 vessels in September 2024 when displaying the 3 groups of vessels in Portugal, Croatia and Ireland on the screen, because 52 vessels were active. Then, when zooming to display only the Portuguese fleet, the same colour palette will adapt to display a maximum of 23 active vessels in Algarve (September 2024).

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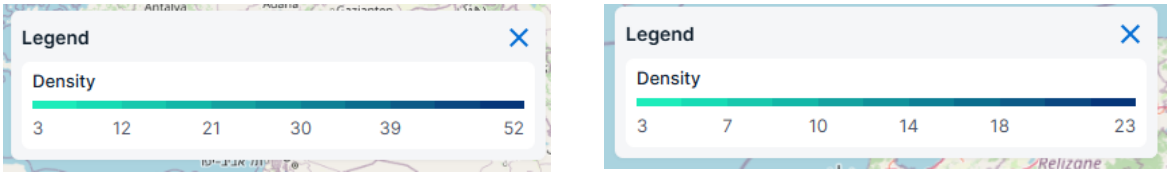

Figure 8 – Dynamic colour palette to display densities of vessels or hours

3.3 VMS Presence (vessels)

Here is an example of the region of Algarve in Portugal during the month of October 2024. Each square represents a number of vessels present at a given time of this month in the square. The exact value is displayed when the pointer hovers above each square. Light green squares represent the minimal number of vessels allowed: 3 vessels.

If there are fewer than 3 vessels in an area, the square is not represented to protect confidentiality of individual activities.

Only active vessels are displayed. Vessels which are at fixed location in the port or at mooring are not displayed. A vessel is considered 'active' if it leaves port at least once during the defined period (day, month or year). We have developed a classification algorithm, with two categories: PORT and OCEAN. This relatively simple machine learning model uses the following input data: distance from the shore, changes in instantaneous and average speed. Positions classified as 'PORT' are excluded from the calculation of maps and dashboards.

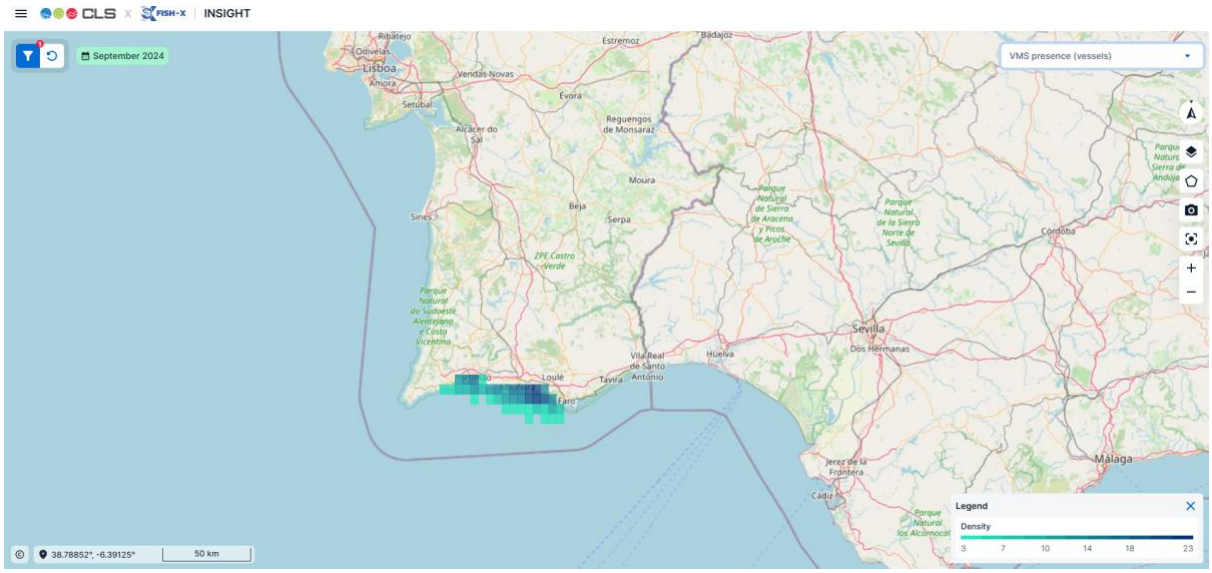

Figure 9 – Map of VMS presence (number of vessels)

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The zooming function influences the number of squares as explained previously, and an effect on the count of vessels which will be explained in the following views taking an example in the Algarve region in September 2024.

Zooming is made by using the + / - buttons in the right menu or using the mouse wheel (or two fingers on a touchpad).

See the example in the Figure 10: Consider a given statistical square where 50 vessels are present in the month. When zooming the square splits in 4 smaller squares with 35, 23, 18 and 10 vessels present in the month. The total number seems to increase, this can be explained as a same vessel may be in different zones during the month, and it will be counted for each zone.

When zooming again, the square with 10 vessels splits in 4 smaller squares but one of these squares is not displayed because fewer than 3 vessels are in it.

To know the total number of vessels in a given area of interest, it is preferable to zoom out and find the square which covers this area. Do not add the number of vessels in small squares.

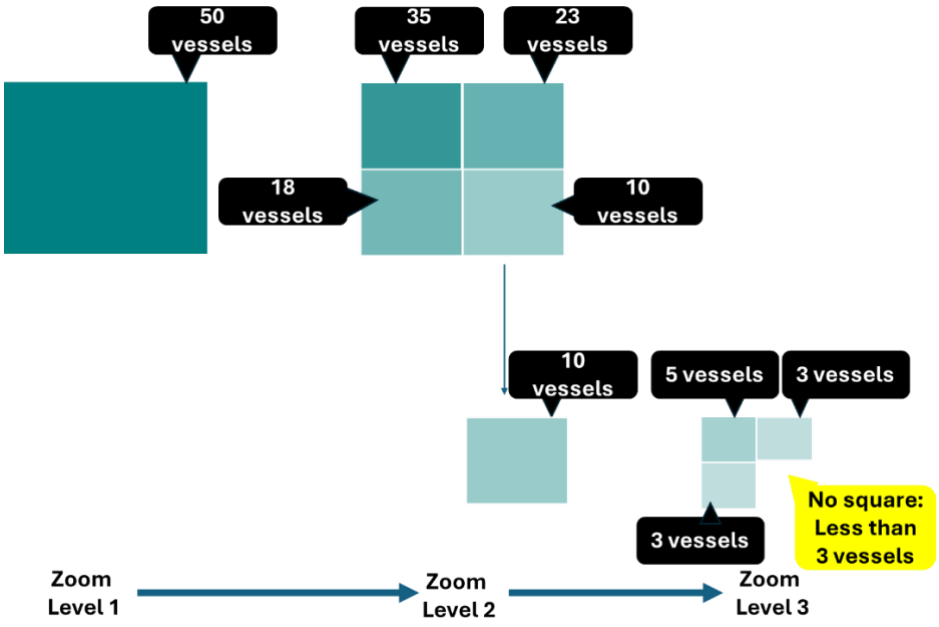

Figure 10 – Statistical squares change of size and effect on vessels numbers

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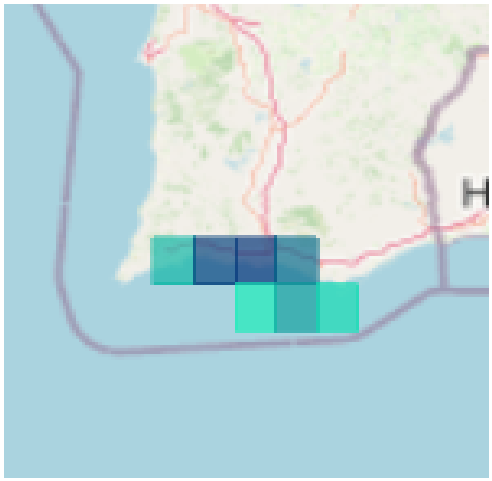
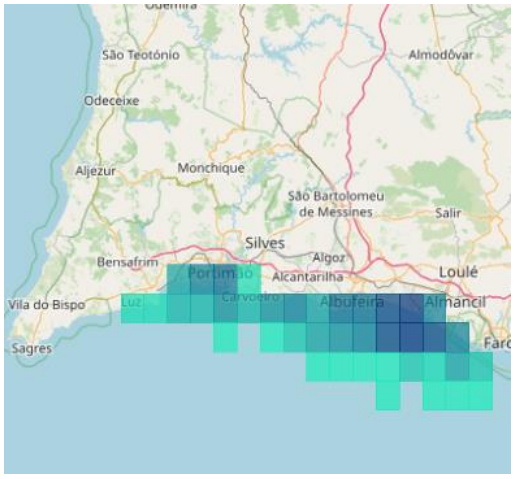
The following example uses real screen shots over the region of Algarve. There are a total of 52 active vessels in Algarve taking part to Fish-X.

1 square of 52 vessels

3 squares of 29, 36, 8 vessels
for a total of 73 vessels



7 squares
for a total of 120 vessels



40 squares
for a total of 403 vessels

Figure 11 – Map of VMS presence (number of vessels) – Effect of zooming on squares

This type of statistical representation is more relevant for enumerating hours than for counting vessels. Typically, the fishing effort calculation will account for all the fishing hours of all vessels in a square. The detailed squares are of interest to determine the number of vessels in a given area, such as a future wind farm or an MPA, but users should avoid adding together the values of several squares.

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3.4 VMS Presence (hours)

Here is the same region of Algarve in Portugal during the same month of September 2024. Each square represents a number of hours spent by any of the vessels. The exact value is displayed when the pointer hovers above each square. Light squares represent minimal numbers (1 or 2 hours). Dark green squares represent peak presence (up to 252 hours for active vessels near the port of Portimão in this screenshot). As explained before, the vessels in port or at mooring are not counted.

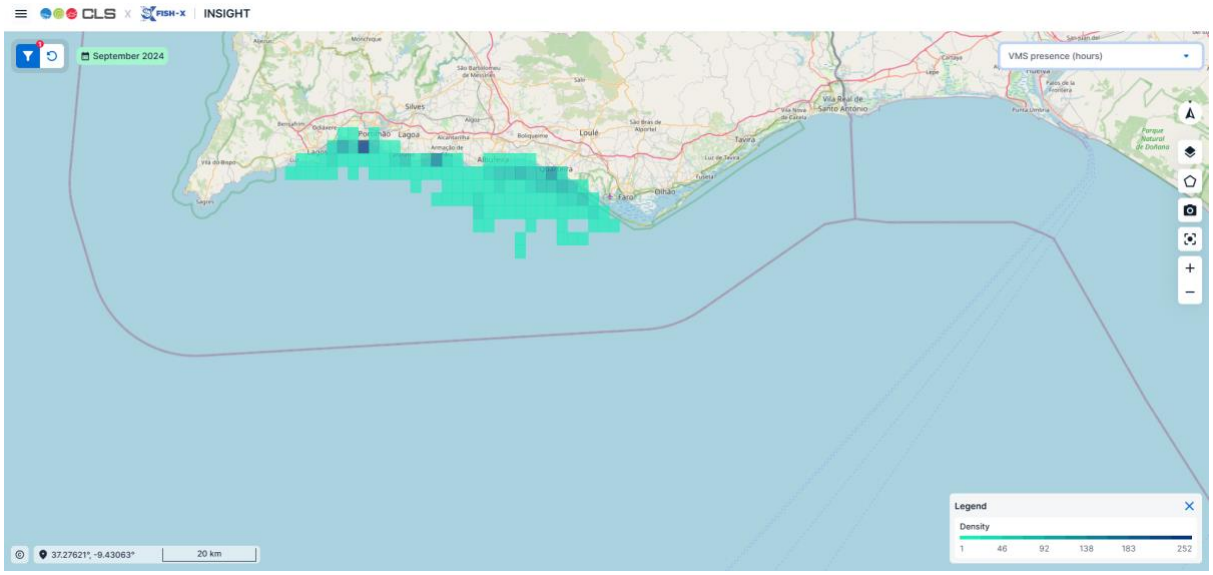

Figure 12 – Map of VMS presence (hours)

The change in zoom level will conserve the cumulated number of hours until the number of vessels drops below 3 vessels in a square. From the zoom level where less than 3 vessels are in the square, the individual hours are not counted.

Some squares with “0 hours” may appear which represent the presence of at least 3 vessels for less than one hour in total (e.g. 45 minutes).

This is illustrated in another area in Croatia, for the same period (September 2024). In the least zoomed view, there are 992 hours of presence distributed over 4 squares. When zooming, the same area is now covered by 11 smaller squares and some of the smaller squares with fewer than 3 vessels are not displayed anymore.

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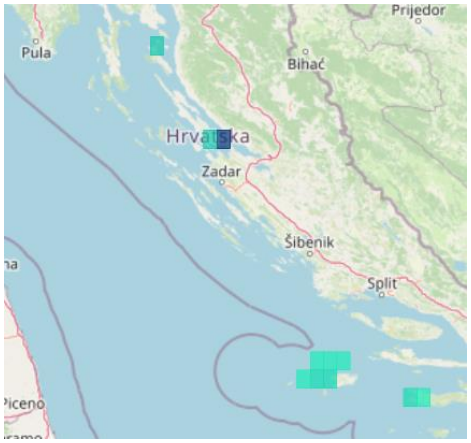
4 squares,
374+179+294+145 = 992 hours in total



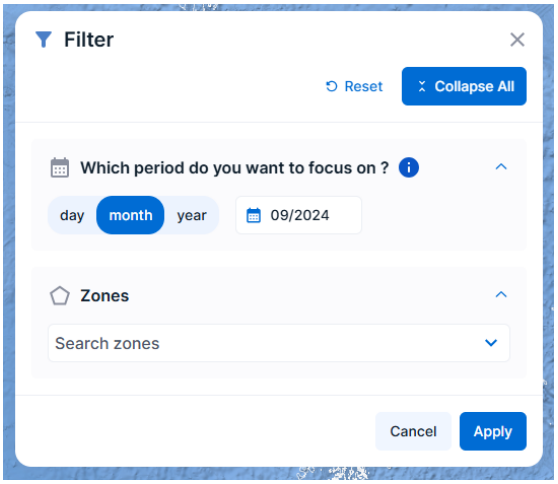
11 squares
161 hours in total after zooming

Figure 13 – Map of VMS presence (hours) – Effect of zooming on squares

3.5 VMS Presence in Zones

It is possible to filter positions in zones of interest using the top left menu (Funnel). The filter selects vessels data only for a list of defined zones. It is possible to filter on wide zones (FAO or GFCM) or Exclusive Economic Zones. To select a zone, scroll the vertical menu in “Search zones” (Figure 14, left).

It may be faster to start typing the first letters of the zone name (e.g. Port for Portuguese EEZ, as in Figure 14, right).



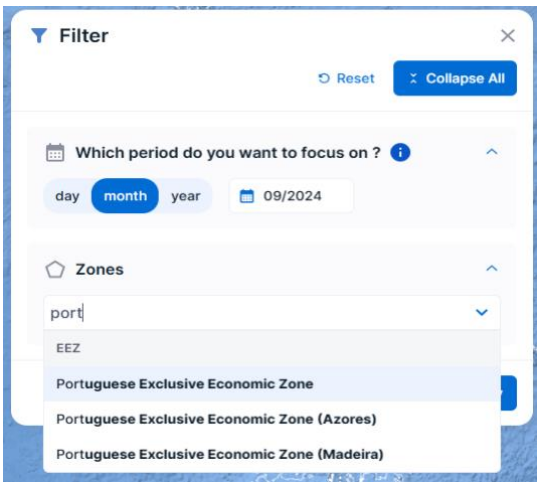


Figure 14 – Filtering positions in zones – Seach Zone or type a zone name

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The effect of the zone filter is illustrated in the two following views.

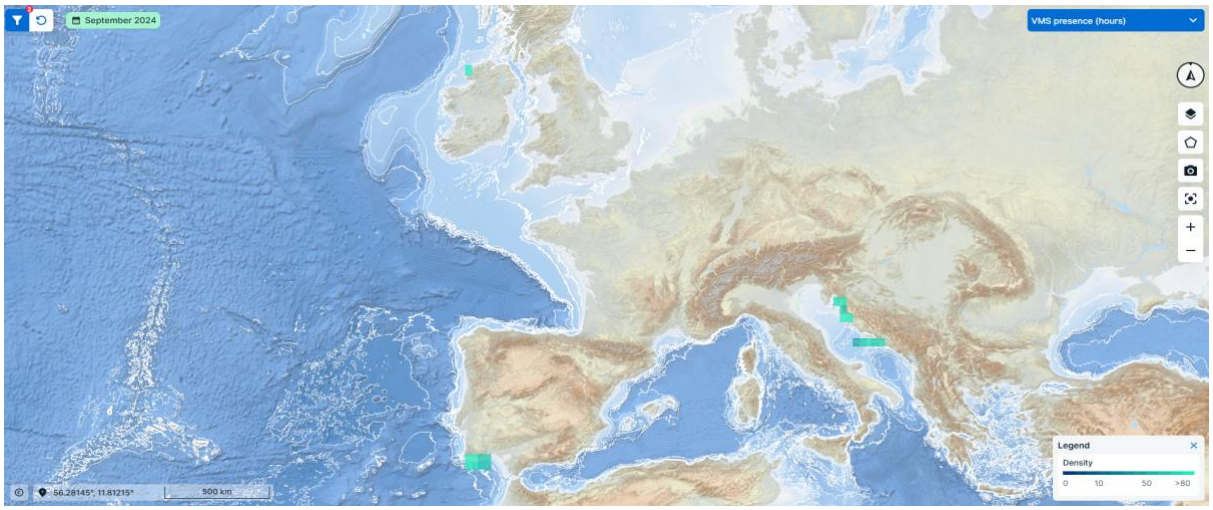

Figure 15 – Map of VMS presence (hours) – No zone filter applied, all three projects are displayed

Without selecting any filter, all three projects in Portugal, Croatia, and Ireland appear. When filtering on the Portuguese EEZ, only the vessels along the coasts of Portugal are displayed.

Figure 16 – Map of VMS presence (hours) – Portuguese EEZ filter applied, only the project in Portugal is displayed

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Filtering vessels in specific zones such as MPAs is possible. For instance, some of the Croatian MPAs have been declared, resulting in very detailed small areas on which fishing vessels activities could be filtered. The process of user upload of more zones and the translation of MPA names in local languages have not been addressed, they could be considered in future evolutions (post project).

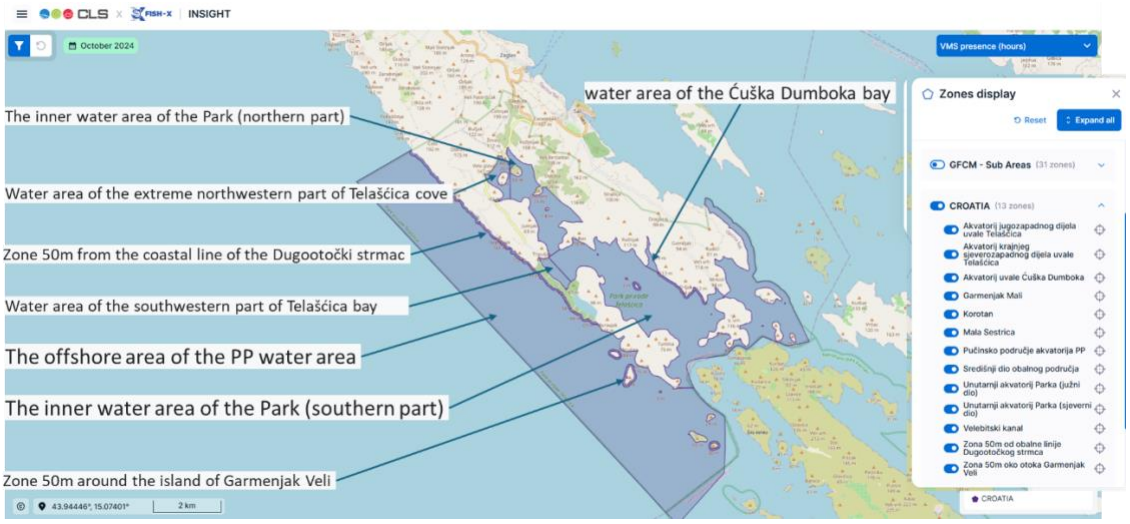

Figure 17 – Croatian MPAs for filtering in Insight

4. Fishing Effort Densities Using AI

4.1 Introduction to the Fishing Effort Calculation

The Insight Platform's main innovation is in the use of AI to analyse the fishing vessels trajectories collected by the VMS devices to produce maps of fishing effort. The objective is to be able to process an estimated fishing effort without prior knowledge of the fishing vessels or the gear used, working on each vessel trajectory day after day. Considering that fishers have obligations to report their fishing activities via their logbook (for vessels above 10 meters in the EU), the objective is not a substitute for control obligations, as the project is managed as a voluntary proof of concept to show potential benefits of AI.

The automatic tools have been developed by CLS during the Fish-X project and a few prior projects, to address the diversity of fishing practices. The notion of fishing effort represents the cumulated impact of an individual or a group of fishing vessels in a given area for a period of time. There are several attempts to standardise the definition of fishing effort, in particular

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by the FAO[2], and scientists consider a more specific definition of effective fishing effort, which is specific to each individual fishing type.

In the Fish-X project we consider a simplified concept of apparent fishing effort based only on trajectories, which could be applied to homogeneous groups of fishing vessels after a training period with a group of documented vessels (*labelling* process). The fishing effort definition depends on the type of fishing gear used, and the fish gear dimensions estimated from the vessel trajectory. **In short, the larger the fishing gear or the longer it stays in the water, the greater the fishing effort.**

For some fishing gears (e.g. trawler), the gear is attached to the vessel and the start and end of the fishing activity are in the same fishing trip. These gears are called active fishing gears. For passive gears (e.g. gillnet, traps) and in particular for small scale fishing vessels, the gear is set and remain underwater for several hours until the vessel returns for hauling the gear. **This actual fishing duration is expressed as the time difference between the end of hauling and the start of setting the net**. This value is used for the calculation of the fishing effort. Estimating fishing duration makes it necessary to analyse consecutive fishing trips for each vessel, identify the hauling, and identify for which previous trip the gear was set.

4.2 Automatic Calculation of Fishing Effort

The method employed by CLS relies on machine learning using documented fishing trips provided by accurate and high-resolution VMS devices and interviews of volunteer fishers at the start of the project. This method could be deployed to more groups of homogeneous fishers and does not require to deploy observers or complex tools onboard the vessels. The method is conducted in two steps, firstly to identify which fishing gear is used, then to estimate the duration of the fishing activity and, if needed, the fishing gear length.

4.2.1 Machine Learning for Identification of Fishing Gear

The first step is to train models on datasets with labels collected during the pilot project, with boats fitted with NEMOs in Portugal, Croatia, and Ireland. The fishers have been interviewed to know their fishing practices and targeted species. Then we run the model to evaluate each new track.

[2] See reports by the Coordinating Working Party on Fishery Statistics (CWP): https://www.fao.org/cwp-on-fishery-statistics/handbook/capture-fisheries-statistics/fishing-effort/en/

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The algorithms are specific to small-scale fisheries which are more polyvalent than industrial fishing vessels and may change their fishing gear from trip to trip.

The datasets used for the training phase need to be properly prepared to remove useless subsets of data. For instance, a preprocessing already explained determines if the vessel is active or not, based on short movements detection. All vessels at mooring are considered as inactive, as well as those in port, and their positions are discarded from the dataset.

A specific model using GMM (Gaussian Mixture Model) is trained for each fishing gear using a data set of vessel trajectories[3]. Presently CLS data scientists have developed 3 models (based on FAO nomenclature) representing:

- **Passive gears** (a group of gears such as gillnets, pots and traps, set longlines),
- **Surrounding nets** (purse seines) used for small pelagic fish or tuna,
- **Pole-and-lines**

More models will be developed in the coming months which could be integrated in the Insight Platform v2.2. The differentiation between the various passive gears is also under study.

After each model has been trained, CLS proceed with the daily analysis of each new vessel trajectory received from non-labelled vessels. The various models are tested and the model which gives the best fitting (minimum value of the log-likelihood function) is selected. Each fishing trip is then associated with one of the above fishing gears.

4.2.2 Measurement of Start and End of the Fishing Activity

The fishing activity refers here to the period during which the fishing gear is actually in fishing operation (so, excluding the transit time). For passive gears, the activity combines 3 phases:

- The **time for setting the gear**,
- The **soaking time** (the gear is in water, not manipulated, catching fish)
- The **hauling time**

In many cases, the speed values are similar for the transit phase (gears unused) and gear setting so it is difficult to estimate where the fishing activity starts. The hauling phase is easier to detect by combining various criteria (slow speed, linear trip except for purse seine). The

[3] The method is inspired by Marzuki, Marza. (2017). VMS data analyses and modeling for the monitoring and surveillance of Indonesian fisheries.

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gear hauling may happen the next day, after the gear was left overnight in water, so not in the same fishing trip.

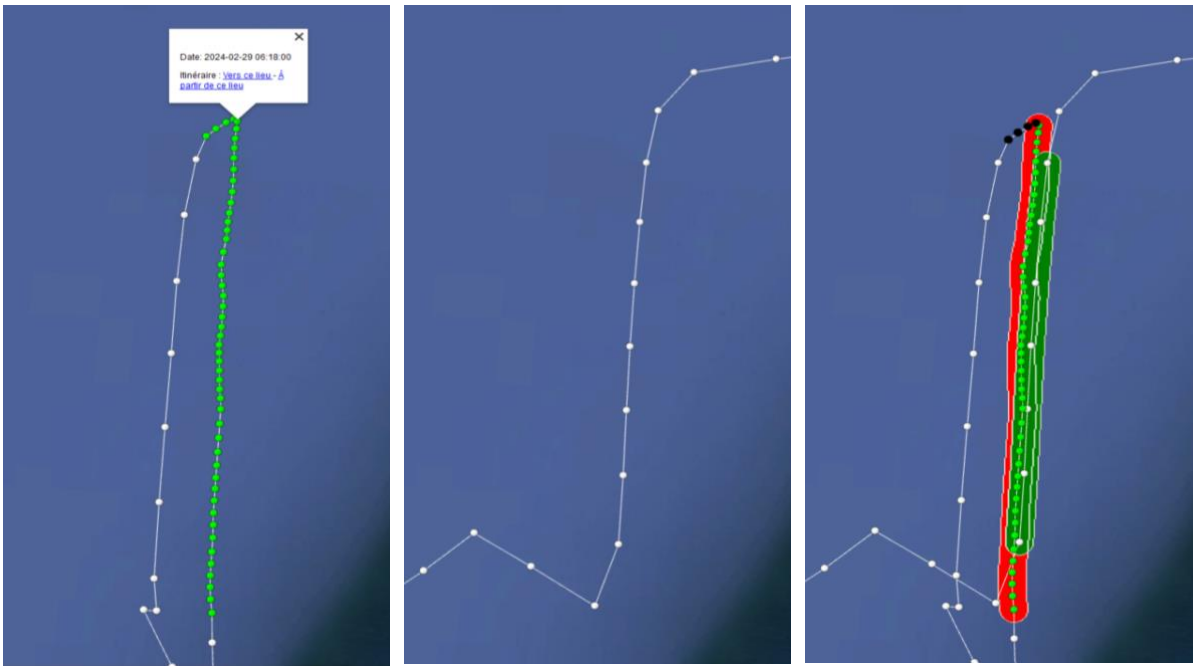

Figure 18 – from left to right: 1) identify hauling trip; 2) search setting trip over previous days, 3) overlapping criteria used to select the most plausible setting trip

See the above three figures of the same vessel over two consecutive days.

Left figure: The process starts by the detection of the **hauling** activity while the vessel is moving from south to north. The possible hauling phase is represented with the green dots.

Central figure: The tool searches for previous **setting** trips over the past few days, which sufficiently overlap with the hauling trajectory selected above. The age of the setting trip is compared to criteria to avoid too long periods between setting and hauling (which could be a confusion of fishing trips if fishers frequently return to the same place).

Right figure: This figure clarifies the process for matching the setting and hauling trajectories ('*track matching*'). We use search polygons to detect the overlapping of set and haul trips, represented in red and green. The times for start of setting and end of hauling are then computed. The black dots which were initially observed as a possible end of hauling phase are finally rejected as not overlapping the setting trajectory.

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The same process includes the calculation of the length of the fishing gear from the trajectories' overlapping.

4.2.3 Fishing Effort Calculation per Statistical Square

As for the VMS densities, the processing is performed day after day, during the night, and applies on the day d-2. If a fishing activity is detected, the following datasets are produced for each vessel:

- Type of fishing gear
- Duration of the fishing activity (a multi-day fishing is dated on the hauling day)
- Length of the fishing gear (if applicable)

From these values the Fishing Effort is processed using a simplified formula[4] for gillnets, pots and traps, and set longlines.

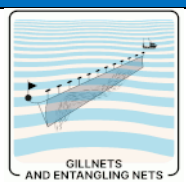
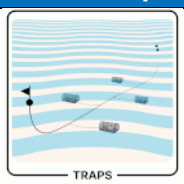
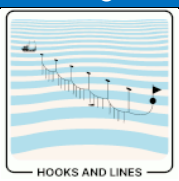
	Gillnets	Pots & Traps	Set Longlines	Purse Seines	Pole & Lines
Fishing gear					
Fishing effort by Insight and unit	Simplified formula: Length x (setting+soaking+hauling times) (hour x kilometre)			Search time (hour)	Fishing time (hour)

Figure 19 – Simplified definition of fishing effort by type of fishing gear

The result is a value of the fishing effort calculated by AI methods. As the fishing gear may cover several hundreds of meters, it must be distributed over the statistical grid. Using the same principle of grid intersections explained in Appendix B, the total fishing effort is distributed over the various statistical squares on which it takes place, *pro rata* temporis in each square.

[4] Compared to official definition of the fishing effort by the FAO, we use one single formula for all three passive gears to cumulate the setting, soaking and hauling times, while FAO apply a 50% factor on the duration of setting and hauling in the case of the longline. This is a minor approximation because for SSF, the setting and hauling times are short compared to soaking time.

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For instance, in the Figure 20 the fishing effort of 50 hours x kilometres could be distributed in 4 different values (FE1, FE2, FE3, FE4, e.g. 10, 20, 5 and 15 hours x kilometres) applying to the 4 squares. This process has to be renewed for each size of statistical grid (see section 3.1).

Finally, all fishing efforts over the same statistical square are cumulated for all vessels.

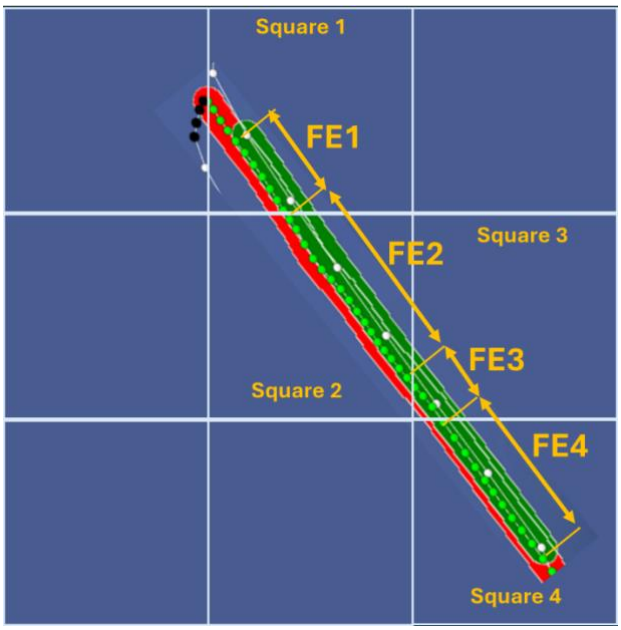

Figure 20 – Distribution of the fishing effort in the statistical grid

4.3 Fishing Effort Density Maps in Insight

Insight v2 represents the fishing effort density maps for each type of fishing gear, using similar conventions as for the VMS presence in vessels or hours.

Select the Fishing effort menu in the top right menu and select the Passive Gears option.

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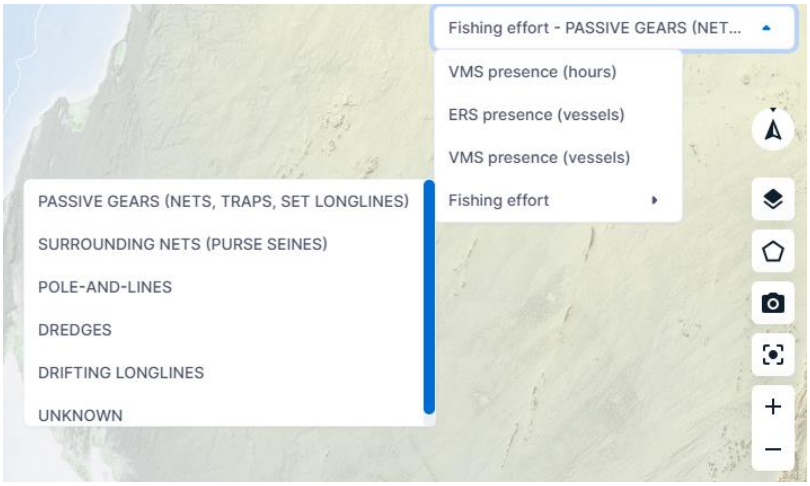

Figure 21 – Menu for Fishing Effort density map

The fishing effort is an indicator used for fisheries management and regulation and the ability to monitor it in near real time is an added value.

The following views illustrate how relevant is the processing of fishing efforts for fisheries managers, compared to standard VMS analysis. Where the VMS give indications of time spent by the vessels, the fishing effort gives the information of the time spent by the fishing gear in use and its capacity to catch.

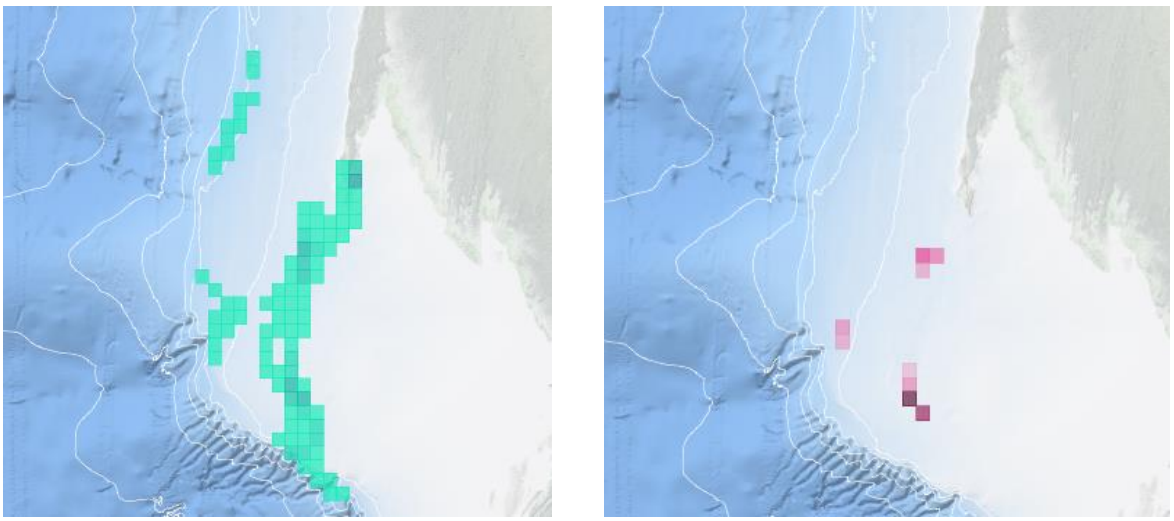

Figure 22 – Compared views of VMS presence (hours) and Fishing effort (hours x kilometres)

In the above figure produced for the month of January 2025, the maximal value for VMS presence is 90 hours (dark green square) cumulated by 4 vessels, or less than one hour

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presence per day per vessel. The maximal fishing effort value in the same square in dark pink is 2058 kilometres x hours. Considering for instance that all these vessels use a fishing gear of 1 kilometre, in average their gears were used 514 hours per vessel, or 16,5 hours each day.

5. Dashboards

Dashboards are a different way to represent the same statistical results. They are accessible in the top left menu next to the CLS and Fish-X logos. The results displayed in the dashboards refer to the same period of time which was selected in the map menu.

Dashboards are composed of two parts: Fishing Oriented (by gear type) and Spatial Oriented.

5.1 Fishing Oriented Dashboard

These dashboards represent a summary of the statistics for the number of vessels, the detection of fishing gears and the fishing effort processed. They are synchronised with the map (selecting a period in the map menu makes the same selection in this dashboard). In the following example, there is a total of 25 vessels using one single type of fishing gear.

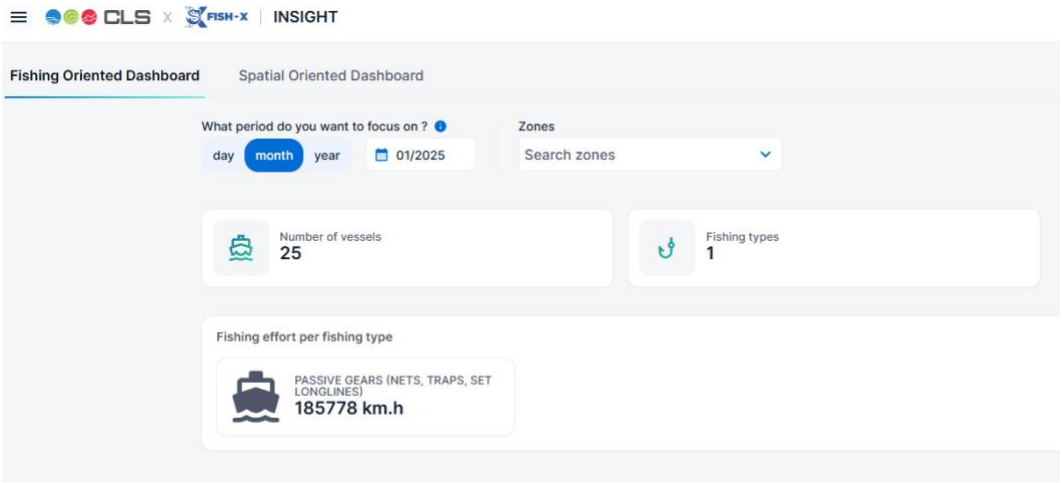

Figure 23 – Fishing Oriented Dashboard, without zone filter

It is also possible to apply the zone filters to display statistics only on the selected zones. For the same period, if the dashboard zone filter is applied (here to show vessels in FAO zone 18) the result will be updated:

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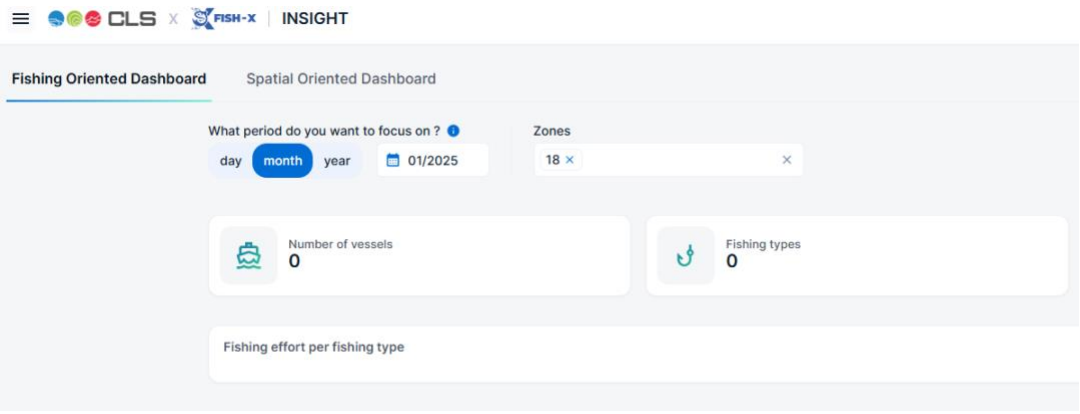

Figure 24 – Fishing Oriented Dashboard, with zone filter (FAO zone 18, no vessels)

5.2 Spatial Oriented Dashboard

The six dashboards provide fisheries statistics and apply on pre-defined zone criteria, in form of bar charts. The time period and the zone filter can be applied.

More details such as number of vessels appear when the pointer hovers over the bar charts. The present dashboards include:

- **Most populated EEZ:** The Portugal EEZ with 56 vessels displayed (exact numbers appear when hovering over the bar chart).
- **Most populated FAO zones:** In October 2024, the zone 27 has 64 vessels.
- **Most populated GFCM Sub-Areas:** In October 2024, 22 Croatian vessels are in the GFCM Sub Area named “Northern Adriatic”.
- **Most populated areas in Croatia:** Velebit Channel
- **Most populated MPA:** no test vessels there
- **Most populated GFCM FRA** (Deepwater FRA defined by all areas deeper than 1000 metre depth): no test vessels there

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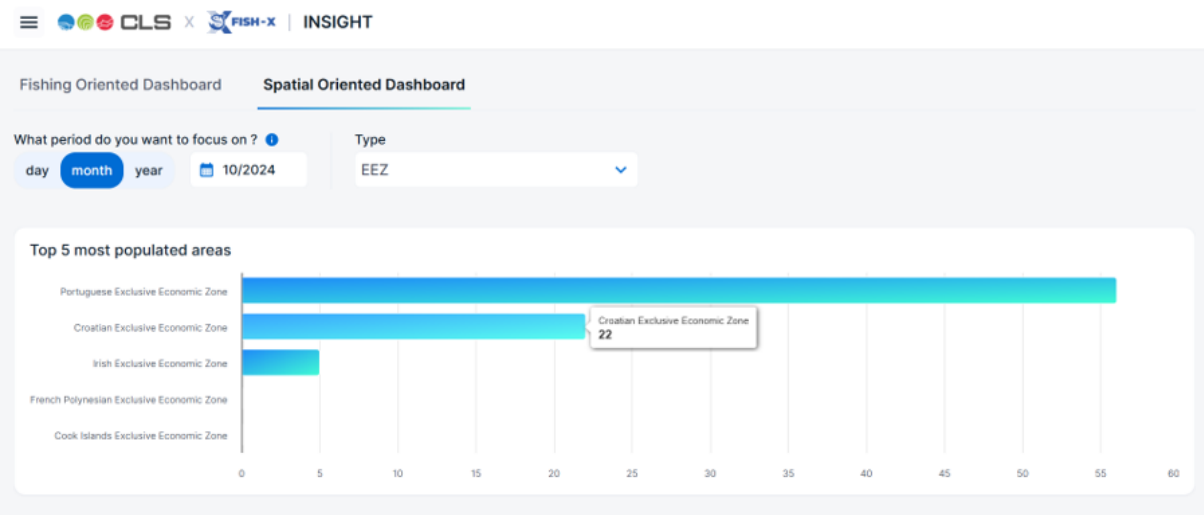

Figure 25 – Dashboard 1: Most populated EEZs (pointer hovers over the Croatian EEZ to display the number)

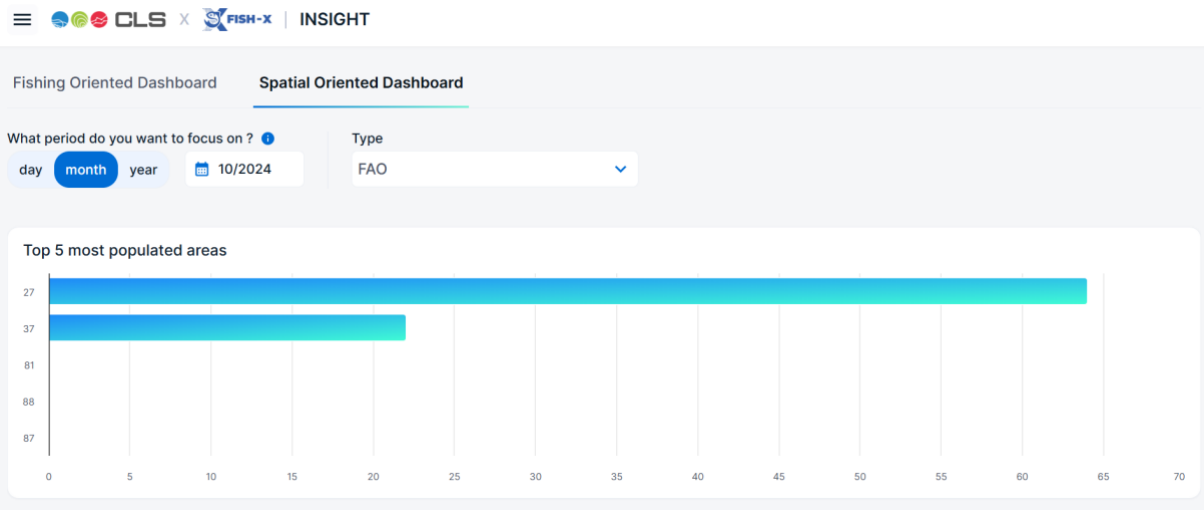

Figure 26 – Dashboard 2: Most populated FAO areas

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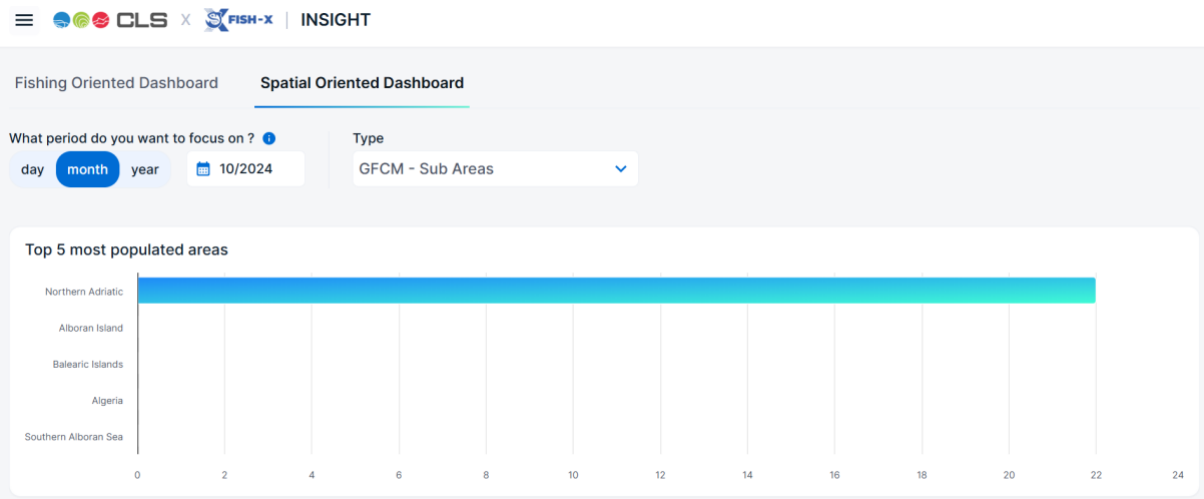

Figure 27 – Dashboard 3: Most populated GFCM Sub Areas

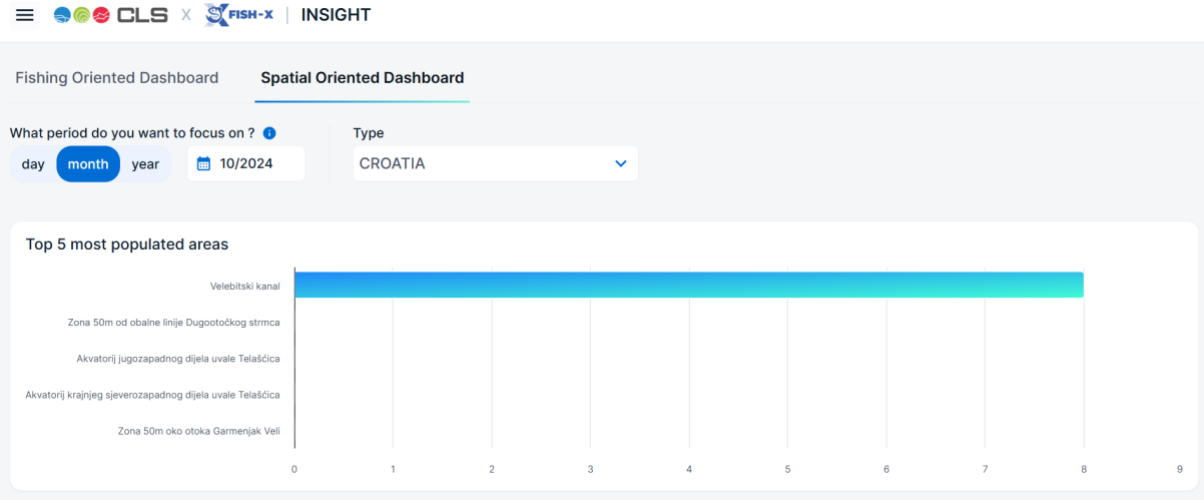

Figure 28 – Dashboard 4: Most populated Croatian MPAs

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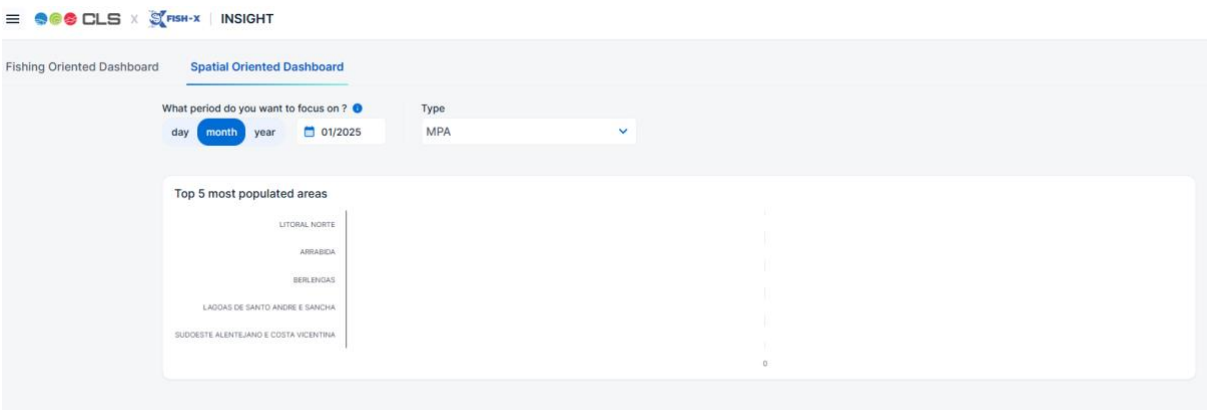


Figure 29 – Dashboard 5: Most populated MPAs (no vessels)

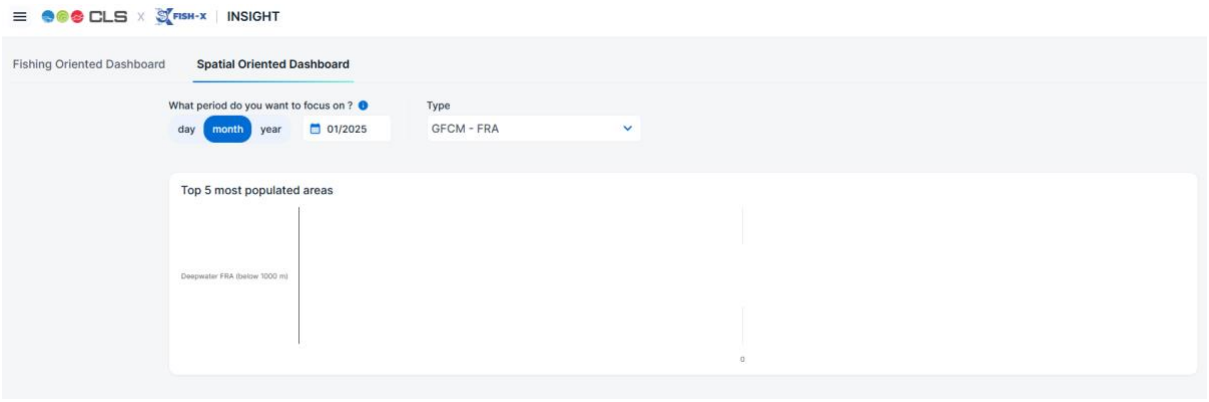
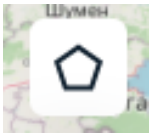


Figure 30 – Dashboard 6: Most populated GFCM Fisheries Restricted Areas (FRA, no vessels)

6. Additional Display Tools

The following tools are accessible from the menu on the right. They are used to modify the background maps and do not affect the datasets displayed.

6.1 Zone Display



This menu is not used for data filtering (refer to section 3.5 for filtering vessels data). The button allows displaying one or several zones on the map, with several types of zones:

- FAO
- GFCM Sub-Areas

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- GFCM FRA (Fisheries Restricted Areas)
- EEZ
- Marine Protected Areas (presently, only MPAs in Portugal are represented)
- Specific national zones (e.g. Velebit Channel in Adriatic Sea)

When hovering the pointer over the area, the names will be displayed (here FAO Zone 57 in Eastern Indian Ocean):

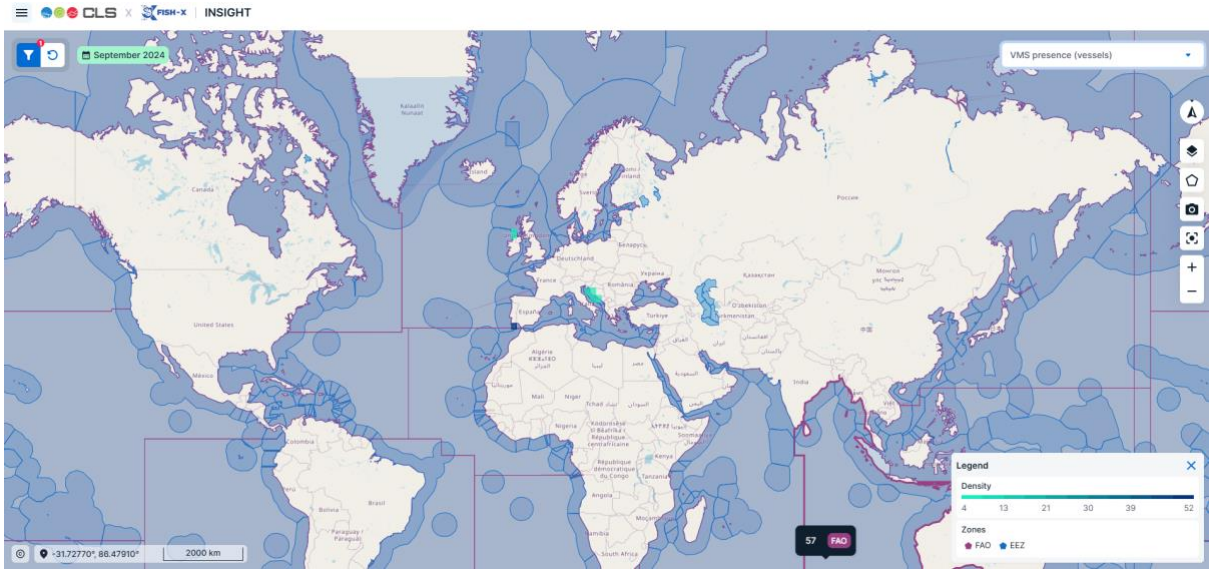
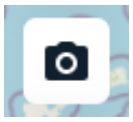


Figure 31 – Zone Display – GFCM Sub-Areas and EEZ layers with names of zones

6.1 Make a Snapshot



This button is used to create a jpg file from a specific map of interest and save it in the download directory.

6.2 Default View

This button is used for quick return to the minimal zoom level.

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6.3 Orientation of the map

Like a navigation application, the Insight map allows rotation in the plane, so the North is not displayed upwards. It can also be projected with a perspective effect. To do that, click and drag the map while pressing the Ctrl key on the keyboard. Return to flat north-south orientation by clicking on the North Up navigation button.

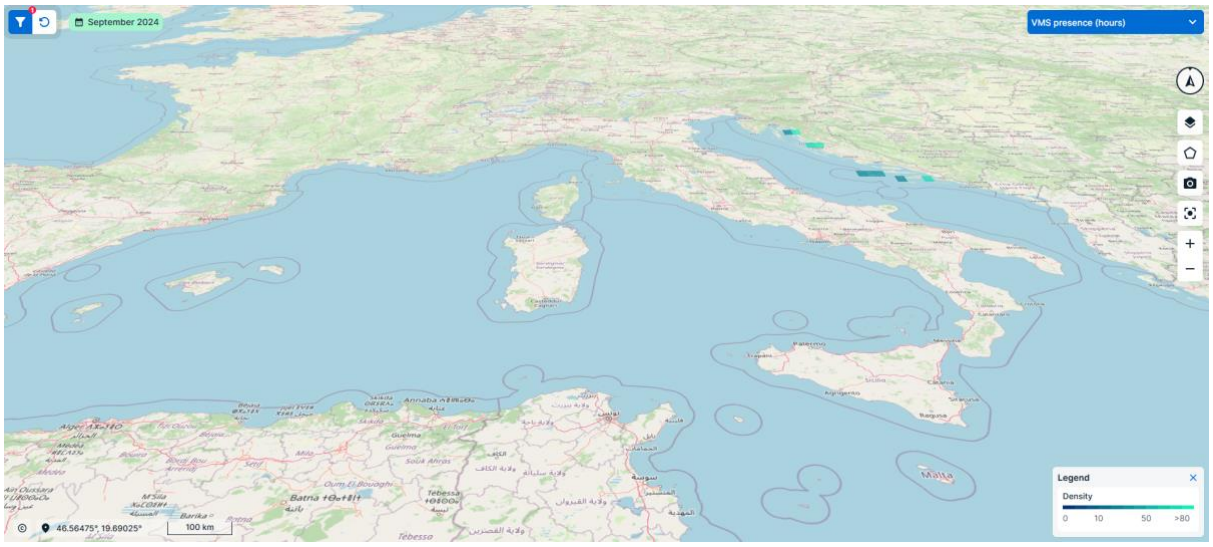

Figure 32 – Map orientation and perspective

6.4 Supported browsers

The latest versions of the following web browsers are supported:

- Chrome,
- Edge,
- Firefox,
- Safari

7. Performance

The Insight v2 platform is hosted on a Cloud provided by AWS (Amazon Web Services), which will allow scalability to maintain a fast response level should the number of users and the volume of data increase. Presently, there are rather small data sets processed from the 110 vessels fitted with NEMO VMS devices during the Fish-X project. Data from August 2024 until November 2024 are already integrated, and data will continuously be integrated until the

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end of the project in May 2025. The fishing effort analysis is produced from February 2025 onwards.

The consortium is now investigating which other ongoing projects could join and contribute by providing past data sets, with respect to all data protection obligations. Insight is by design able to scale up and accommodate 100.000 vessels or more, with vessel positioning at frequent intervals (typically 3 minutes) and daily electronic logbooks (in the v2.2 version).

The objective response times are as follows:

- Display the whole world density Map in less than: 10 s.
- Display a density Map using an EEZ or an FAO area as a filter in less than: 2 s.
- Display a density Map using a FRA or a sub-FAO area as a filter in less than: 1 s.

The response times have been tested with an Insight integration platform (not open to public) using a global AIS data feed to verify the load capacity. 36.000 vessels with 2.2 million positions were loaded. More tests are in progress.

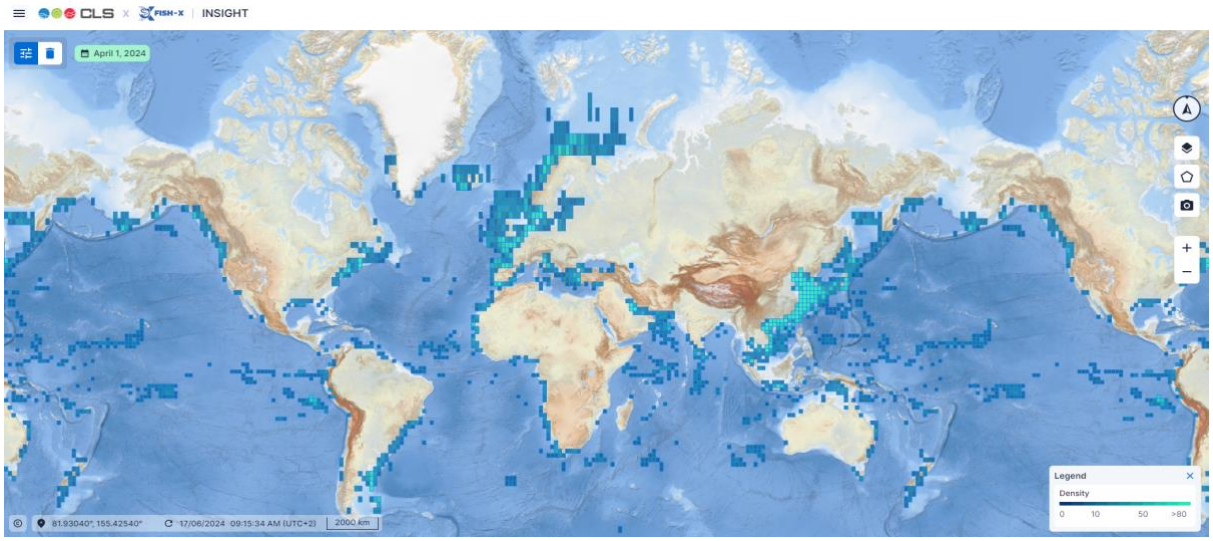

Figure 33 – Insight load test with global AIS feed

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8. Appendix A: Relation between the squares' dimensions and the zoom level

All vessels' data are aggregated into statistical squares to illustrate the impact of fishing on each maritime area over periods of time (day, month, year).

There are seven sizes of squares, expressed in portions of degrees. Every region on the Earth's surface can be referenced by its coordinates, and surfaces can be defined by its bordering latitudes and longitudes, for instance 35°- 36°N / 15°-16°E. The parallels (circles at a given latitude) are smaller when approaching from the Equator to the Poles. When the statistical squares are converted from degrees to km, they appear to change of dimensions, their horizontal size is reducing for more northern latitudes with the vertical dimension remains unchanged.

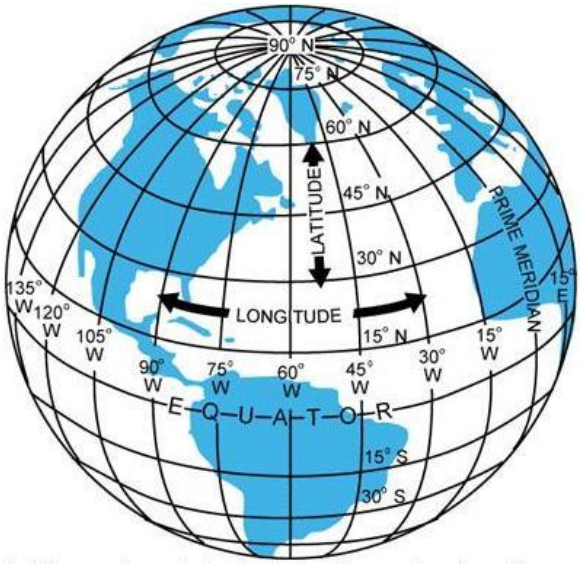

Figure 34 – Meridians and parallels defining coordinates on Earth

If users need to convert the statistical squares to kilometres, the approximate conversion for the three Fish-X test sites is as follows:

Zoom level	Size in degree	Approximate vertical size in km	Approximate horizontal size in km (in	Approximate horizontal size in km (in	Approximate horizontal size in km (in

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			Algarve 37° latitude)	Croatia 44° latitude)	Ireland 54° latitude)
1	1.6°	177,8	142,0	127,9	104,5
2	0.8°	88,9	71,0	63,9	52,2
3	0.4°	44,4	35,5	32,0	26,1
4	0.2°	22,2	17,7	16,0	13,1
5	0.1°	11,1	8,9	8,0	6,5
6	0.05°	5,6	4,4	4,0	3,3
7	0.025°	2,8	2,2	2,0	1,6

Figure 35 – Statistical squares dimensions in degrees and approximate degrees

Above approximate values assume a round shape for the Earth, while it is in reality a geoid.

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9. Appendix B: Calculation of Time Presence in a Zone

The calculation of vessels presence in a zone (e.g. a statistical square) is based on the analysis of its trajectory. The trajectory is composed of consecutive locations, each of them associated with a time stamp. The interval between two consecutive locations depends on the VMS settings. Typically, the NEMO VMS devices used in Fish-X transmit a position every 3 minutes, but they could be set to different, less frequent intervals (e.g. 15 or 60 minutes).

To calculate the total number of hours spent in a statistical square, a dedicated algorithm is applied:

- It cumulates the times between consecutive VMS positions located inside the statistical square.
- For two consecutive VMS positions crossing the statistical square limit, it calculates the portion of the time interval in each square. If several squares are crossed between the two consecutive positions, a portion of time is calculated for each square, using a linear interpolation assuming that the vessel speed is fixed between two VMS positions. This latter case is illustrated with two consecutive positions (red dots) in different statistic squares, the algorithm processes the time intervals in each square (transit time from blue dot to blue dot):

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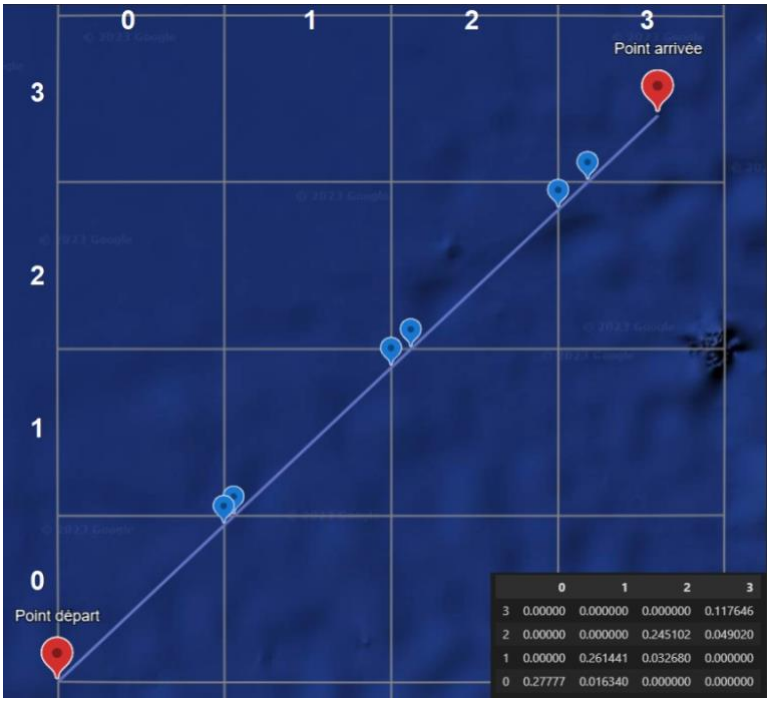

Figure 36 – Calculation of entry and exit times for each statistical square

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10. Appendix C – Definition of Terms

AIS: Automatic Identification Systems is a position reporting system primarily designed as an aid to navigation and safety at sea. AIS collects vessel positions at variable intervals (depending on their speed). AIS is installed on all types of merchant vessels (tankers, passengers, container carriers etc). AIS is not mandatory for vessels below 15 meters in the EU. Access to AIS data is provided by commercial suppliers which operate satellite constellations listening to AIS terminals onboard vessels, or through coastal receivers. A major difference of AIS with VMS is that vessels are allowed to switch off their AIS, if it may represent a threat (e.g., navigating in piracy areas), therefore, AIS cannot be used alone for enforcement of fisheries regulations.

ERS: Electronic Reporting Systems allow fishers to report their activities manually, without using paper logbooks, in compliance with EU regulations applicable for vessels above 12 meters, soon to be extended to all vessels. The reports are necessary for measurement of fishing impact on fish stocks, with sufficient level of precision (per area and per species). The reports contain a unique identifier of the fishing trip and details of fishing trips from port departure to return to port, with a list of catches and quantities, specific events such as entry or exit of zone. The new EU control regulation will require SSF to report electronically (e.g., smartphone app) after each fishing trip before landing their catches including interactions with vulnerable species and lost fishing gears.

Fishing Effort: According to the FAO:[5] "Fishing effort is generally defined in terms of the time spent searching for fish (search duration) and/or the amount of fishing gear of a specific type used on the fishing grounds over a given unit of time e.g. a fishing operation, fishing activity, day or fishing trip. The measure of effort (unit of fishing effort) depends on the fishery and type of gear used." The fishing effort represents the resources involved in the catching of fish, generally proportional to a duration of activity and a function of the fishing gear efficiency (number of hooks in a longline, or traps or lines for other techniques). In the context of the Insight Platform, the fishing effort will be the result of a calculation based on the vessel trajectory and additional data.

[5] https://www.fao.org/cwp-on-fishery-statistics/handbook/capture-fisheries-statistics/fishing-effort/en/

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Gaia-X: Gaia-X is an EU-initiative focused on crafting a software framework for regulating and governing cloud and edge technology stacks. It establishes a shared set of policies and regulations to promote transparency, controllability, portability, and interoperability across data and services. Gaia-X's architectural foundation is rooted in the decentralisation principle, resulting in a cooperative ecosystem of individual platforms that adhere to a common standard. The Gaia-X standard is dedicated to developing a data infrastructure founded on the principles of openness, transparency, and trust. So, what emerges is not a cloud, but a networked system that links many cloud service providers together, who keeps control of its own data.

Through Gaia-X, the formation and enhancement of data spaces are facilitated by trusted platforms that uphold consistent rules. This framework fosters mutual trust between users and providers on an objective technological basis, allowing them to exchange data securely and freely across multiple entities. The Fish-X Data Space builds on this initiative and hence offers its users the accompanying benefits.

Marine Chart: In this present context, marine charts are digital charts used as background of vessels locations, to help understanding the fishing activities with regards to the bathymetry and other features (buoys, protected areas etc). They are not used for navigation.

UI: User Interface screens with series of menus, selection buttons, etc available through an app on a smartphone, or through a web browser.

VMS: Vessel Monitoring System is a position reporting system which collects vessel positions at regular intervals (e.g., every two hours in the EU) imposed by most fisheries regulations in the world, applicable to all fishing vessels in the EU above 12 meters in length fishing for more than 24 hours, and this regulation will be progressively extended to vessels below 12 meters until 2030. The vessel masters are obliged to maintain an active VMS onboard, and interruption of VMS reports may be considered as infringements if not justified (e.g., vessel in port).

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