SIFIDS

Scottish Inshore Fisheries Integrated Data System

Work Package 6 Supplement to Final Report

Development of a Relational Database and User Interface

Project code: WP00(6) Supplement SIFIDS

EMFF: SCO1434

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EXECUTIVE SUMMARY

The Scottish Inshore Fisheries Integrated Data System (SIFIDS) project was designed to develop relatively low cost, open source, prototypic systems and processes to collect data from inshore fishing vessels. The vision was that data should, as far as possible, be collected automatically and autonomously and be of use for fisheries management including stock assessment, compliance and marine planning purpose. In addition, fishers should be central to the collection of data and opportunities to maximise the utility of the data collected was explored.

An open source database was created using PostgreSQL together with a Graphic User Interface to allow the interrogation of the database using structured queries and generating graphical and tabular outputs as examples. The database is queried and the outputs visualised using R Shiny which is also an open source programming environment.

Vessel track data was collected using a commercially available tracking system which was selected on the basis of specified criteria that align with the requirements needed for use on inshore fishing vessels. The original database was developed by Seascope Ltd under Work Package 6 of the SIFIDS project. It was designed to accept data from the On Board Central Data Collection System (OBCDCS). This supplementary report to the WP6 Final Report documents the work undertaken by the University of St Andrews team in expanding the database to accommodate additional data streams from the SIFIDS App (see WP5 Final Report) and the low cost vessel tracking system also described in this report.

An open source Advanced Programming Interface (API) has also been adapted to link the low cost tracking system to the database.

Based on the criteria discussed in this report, the Teltonika FMB204 tracker was selected for piloting as the low cost tracking system. We recommend that these devices or ones with similar characteristics are used to provide near real time vessel track data. Used in conjunction with an App designed to capture catch and landings data, it is possible to derive a range of metrics to address many of those required to further the management of the inshore sector. We also recommend that OBCDCS units together with gear sensors be deployed on a selection of vessels acting as reference fleet to provide validation data. Further development of the Automated Species, Sex and Size Identification Device (ASSSID) (documented in WP2 Final Report) would allow the semi-automated collection of data required for stock assessment purposes.

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ACKNOWLEDGEMENTS

The authors would like to thank Seascope for the development of the initial WP6 database and user interface and for their subsequent advice and support in the further development of this system. We acknowledge Marine Scotland and the European Maritime and Fisheries Fund for supporting this project financially (Grant number EMFF: SCO1434).

SUPPLEMENTARY DATABASE AND USER INTERFACE DEVELOPMENT

1. INTRODUCTION

A prototypic open source PostGreSQL (https://postgresql.org/) relational database together with a web-based Graphical User Interface (GUI) was created under Work Package 6 (WP6)[1] of the Scottish Inshore Fisheries Integrated Data System (SIFIDS). Whilst WP6 was progressed to the point of use for the collection of the On Board Central Data Collection System (OBCDCS) WP 2a and b[2], further development of the system was required to accommodate the acquisition of data from the low cost tracking system described below which became the favoured option for tracking the majority of vessels, once the ability to infer fishing activity from track alone was confirmed (see Final Report for WP8b)[3]. The WP6 database was transferred form a cloud-based server used for its initial development to a secure server based at the University of St Andrews. This report should be read as a supplement to the WP6 Final Report. It documents the:

1. Selection criteria and functionality of the low-cost tracking device
2. Structure of the upgraded WP6 relational database
3. Advanced Programming Interface (API) to link the tracker and the database
4. GUI development to enable tiered access to the database together with example outputs

All SIFIDS code can be found here: https://github.com/StAResComp/sifids_web

2. APPROACHES

Selection criteria for low cost tracking devices.

There are a number of vessel monitoring systems (VMS) designed for inshore fishing vessels on the market and these were reviewed as part of the FishPi[2] – Strengthening Regional Co-operation in Fisheries Data Management (DG MARE Annexes to Summary Report. Supplementary Material. Matrix evaluation of different methodologies used to collect SSF data.p.356; Annex 5.2 Progress, challenges, and data gaps: towards standardisation of electronic reporting in small scale fisheries in Europe p.365)[4]. Table 1 is taken from that report.

[1] Tidd, A.N., Ayers, R.A., Course, G.P. and Pasco, G.R (2019). Scottish Inshore Fisheries Integrated Data System (SIFIDS): Development of a Pilot Relational Data Resource for the Collation and Interpretation of Inshore Fisheries Data. Published by MASTS. 49 pp.

[2] Ayers R., Course G.P. and Pasco G.R., 2019. Scottish Inshore Fisheries Integrated Data System (SIFIDS): Development of an Autonomous Fisheries Data Harvesting System and Investigations into Novel Technological Approaches to Fisheries Data Collection. Published by MASTS. 174pp.

Course G.P. Pasco G.R., Royston, A. and R. Ayers, 2018. Scottish Inshore Fisheries Integrated Data System (SIFIDS): ON-BOARD OBSERVERS Published by MASTS. 45pp.

[3] Mendo, T., Smout, S. Ransijn, J., Durbach, I., McCann, P., Crowe, S. Carulla Fabrega, A., de Prado. I., James, M. 2019. Scottish Inshore Fisheries Integrated Data System (SIFIDS): Identifying fishing activities and their associated drivers. Report to Marine Scotland in fulfilment of EMFF: SCO1413 68pp.

[4] https://www.masts.ac.uk/media/36863/fishpi2-final_v4_annexes.pdf

The report documents the information that could be ascertained on the functionality, costs and any case study examples that could be found on specified electronic reporting equipment for use on small scale fishing vessels. The majority of inshore vessel monitoring systems (iVMS) appear to be marketed on the basis that the purchaser buys the equipment, data management services and associated software. Many of these systems are relatively expensive as a result, when compared to conventional vehicle tracking systems used in the road transport sector that offer the same or greater functionality without the constraint of using the vendors/manufacturers software and services. As the philosophy driving the SIFIDS project was to explore the potential to use open source and, as far as possible, off the shelf, low costs solutions, we investigated a number of tracking systems that offered similar functionality to available iVMS.

The following criteria guided our consideration of available tracking options:

The device must have the following functionality:

1. Capable of use at sea on a small scale fishing vessel and rated to at least IP67
2. Operate on the basis that is capable of recording position to within ~10m derived from the reception of Global Navigational Satellite System (GNSS) data
3. Receive and transmit data using Global Packet Radio Signal (GPRS) and Global System for Mobile (GSM)
4. Ability to store and forward GNSS data to accommodate for loss of mobile network signal
5. Capable of using 2G of greater Subscriber Identity Module (SIM) card and preferably a multi-network SIM
6. Robust electronic circuitry capable of dealing with wide supply voltage fluctuation
7. Continue to function for more than 48 hours in the absence of external power supply
8. Remotely configurable with respect to reporting rates and power consumption
9. Built in anti-tamper functionality
10. Preferably work without the need for external aerials for GNSS/GPRS/GSM
11. Conform to all standard European and domestic regulatory requirements for electronic devices of this type
12. Have easily accessible documentation and technical support
13. Capable of transmitting and receiving data from a third party server (not requiring bespoke API or routing via the manufacturers server)
14. Other considerations included, cost, small form factor and ease of fitting.

In addition to the above specifications, we also considered the stability (longevity) and scale of possible suppliers of suitable tracking units.

Table 1. List of manufacturers interviewed and their ERS

Manufacturer	Product	Mobile phone application or installed on-board system?	Used in a stakeholder case study?
Anchor Lab K/S	MOFI App	App	Y
Anchor Lab K/S	Black Box R2	on-board system	Y
Marine Instruments	WatchMan Pro	on-board system	N

Marine Instruments	Electronic Eye	on-board system	N
Anon. 1	Anon. 1	on-board system	N
Archipelago Marine Research Ltd.	Observe hardware, Interpret software	on-board system	Y
SRT Marine Systems plc	VMS system – B300 AIS class transceiver	on-board system	N
AST Marine Sciences Limited	iVMS Guardian App	App	Y
AST Marine Sciences Limited	iCatch App	App	Y
AST Marine Sciences Limited	Autonomous VMS (aVMS)	on-board system	Y
SIFIDS - University of St Andrews	SIFIDS mobile phone App	App	Y
SIFIDS - SeaScope Fisheries Research	On-board Central Data Collection System (OBCDCS)	on-board system	Y
Anon. 2	Anon. 2	on-board system	N
Vericatch	FisheriesApp	App	N
WWF-US	Electronic Fishing Logbook	App	N

Rationale for tracker technology selection

Terrestrial fleet transport systems are robust, supplied in large numbers and some are ideally suited to use on small scale vessels without modification. The size of the terrestrial logistics and commercial transport sector dictates that the devices, systems and processes available for movement tracking are significantly cheaper than those that have been developed specifically for tracking small scale fishing vessels – where thus far, there has been the potential to significantly offset the cost of purchasing these devices (iVMS) with EU grant funding. Such subsidies may not be available in the future and therefore the tracking and electronic monitoring solutions available to the industry must be robust and affordable in their absence.

Subject to a detailed internet search and consultation with experts, we selected Teltonika as a supplier of tracking devices for the purposes of the SIFIDS project. Teltonika has been creating and developing “Internet of Things” technologies for 21 years with an annual turnover of 60 million Euros, currently they have 800 employees. Main business areas include: vehicle telematics and networking solutions, additionally providing Original Design Manufacture (ODM) and Electronics Manufacturing Services (EMS). Current production capacity is 600,000-1,000,000 devices per month. They sell between 8,000 and 10,000 FMB202/204 units per month. This is the tracker model we would propose to fit to the Scottish inshore fleet (https://wiki.teltonika.lt/view/FMB204_CE_/_RED) for trial purposes in the first instance.

Teltonika devices were selected for testing as part of the SIFIDS project on the basis of their excellent technical specification, scalability, remote configuration capability, and our ability to develop open-source software to communicate with these devices (and others with similar communications protocols) without recourse to third party suppliers. Unit price and the stability and size of the Teltonika company (https://teltonika-iot-group.com/) were also part of our consideration. Teltonika was founded more than 20 years ago, is expanding and has a turnover of ~50m Euro per year. In addition, they provide excellent technical support and documentation for their products and have a dedicated UK representative.

The scale of the road transport sector dictates that competition and economies of scale are strong drivers for tracking device developers and manufacturers. Our experience of dedicated "iVMS" units designed specifically for fishing vessels is that they are relatively expensive and the companies involved generally operate on business models that require the purchase of their equipment and the ongoing supply of backend services. Some of the companies operating in this capacity are relatively small and economically fragile.

Based on the above criteria, we tested the Teltonika FMB202 and FMB204 tracking devices. The only difference between these devices is that the FMB204 has a larger internal battery and is therefore capable of functioning for a longer period in the absence of an external power supply.

The Teltonika FMB204 is a waterproof (IP67) tracker with Bluetooth connectivity, internal high gain GNSS and GSM antennas and integrated high capacity backup battery. The FMB204 with LiPo battery can work up to 6 days in power saving mode. The 6-30V power supply makes FMB204 suitable for use on a variety of small fishing vessels with variable power supplies.

By using GPRS communications and a multi-network Subscriber Identification Module (SIM) card, it is possible to achieve reasonable data transmission coverage around much of Scotland's coastal waters. The ability to store and forward data as part of the proposed tracking technology, also ensures that when there is no mobile reception the stored track data is transmitted once reception is regained. As each device communicates directly with the server that stores the data, it is not visible to other parties, without permission to access these data. GPRS technology is inexpensive and data transmission charges well within the compass of an inshore vessel's operational costs. Further details of costs are provided below.

Data transmitted from each vessel at a prescribed reporting frequency (see for example Mendo et al., 2018) are sent to a common relational database. In practice, this may for example, equate to ~1600 vessels separately reporting positional and other data to the database every 60 seconds whilst at sea.

Technical description

MODULE

Name	Teltonika TM2500
Technology	GSM/GPRS/GPS/BLUETOOTH
GNSS	GPS, GLONASS, GALILEO, BEIDOU, SBAS, QZSS, DGPS, AGPS
Receiver	33 channel
Tracking sensitivity	-165 dBM

Accuracy	< 3 m
Hot start	< 1 s
Warm start	< 25 s
Cold start	< 35 s
CELLULAR	
Technology	GSM
2G bands	Quad-band 850 / 900 / 1800 / 1900 MHz
Data transfer	GPRS Multi-Slot Class 12 (up to 240 kbps), GPRS Mobile Station Class B
Data support	SMS (text/data)
POWER	
Input voltage range	6 – 30 V DC with overvoltage protection
Internal Back-up battery	1800 mAh Li-Ion battery (6.66 Wh)
Power consumption	At 12V < 2,1 mA (Ultra Sleep) At 12V < 3,9 mA (Deep Sleep) At 12V < 4,2 mA (Online Sleep) At 12V < 15,7 mA (GPS Sleep) At 12V < 28,3 mA (nominal)
BLUETOOTH	
Specification	4.0 + LE
Supported peripherals	Temperature and Humidity sensor, Headset, OBDII dongle, Inateck Barcode Scanner, Universal BLE sensors support
INTERFACE	
Digital Inputs	3
Digital Outputs	2
Analog Inputs	1
1WIRE DATA	1
1WIRE POWER	1
GNSS antenna	Internal High Gain
Cellular antenna	Internal High Gain

USB	2.0 Micro-USB
LED indication	2 status LED lights
SIM	SIM
Memory	128MB internal flash memory

PHYSICAL SPECIFICATION

Dimensions	72,5 x 73 x 27,3 mm (L x W x H)
Weight	205 g

OPERATING ENVIRONMENT

Operating temperature (without battery)	-40 °C to +85 °C
Storage temperature (without battery)	-40 °C to +85 °C
Operating humidity	5% to 95% non-condensing
Ingress Protection Rating	IP67
Battery charge temperature	0 °C to +45 °C
Battery discharge temperature	-20 °C to +70 °C
Battery storage temperature	-10 °C to +45°C

FEATURES

Sensors	Accelerometer
Scenarios	Green Driving, Over Speeding detection, Jamming detection, DOUT Control Via Call, GNSS Fuel Counter, Immobilizer, Excessive Idling detection, Unplug detection, Towing detection, Crash detection, Auto Geofence, Manual Geofence, Trip
Sleep modes	GPS Sleep, Online Deep Sleep, Deep Sleep, Ultra Deep Sleep
Configuration and firmware update	FOTA Web, FOTA, Teltonika Configurator (USB, Bluetooth), FMBT mobile application (Configuration)
SMS	Configuration, Events, DOUT control, Debug

GPRS commands	Configuration, DOUT control, Debug
Time Synchronization	GPS, NITZ, NTP
Fuel monitoring	LLS (Analog), OBDII dongle
Ignition detection	Digital Input 1, Accelerometer, External Power Voltage, Engine RPM (OBDII dongle)
CERTIFICATION & APPROVALS	
Regulatory	CE/RED, E-Mark, EAC, RoHS, REACH

The Teltonika trackers have been fitted to 7 vessels in two forms:

1. As direct fits with the units being wired directly into a power supply connected to the vessels ignition system. The purpose being to ensure that as soon as a vessel's engine is turned on, the tracking unit is also turned on and receives power to operate and recharge its battery.
2. As solar powered tracking units developed at the University of St Andrews – the specifications for which are provided in Annex 1 to this report.

The purpose of the solar powered version of the tacking solution was to be able to test the potential to deploy trackers on vessels that do not have adequate power supply to be directly fitted with a tracking device.

Tracker configuration

Teletonika trackers can be configured using FOTA Web. This is a web interface that allows an administrator to change the way the tracking device functions. Configuration files can be distributed electronically to one or many devices as the same time. Detailed explanations regarding configuration can be found at: https://wiki.teltonika.lt/view/Manual

3. RELATIONAL DATABASE DEVELOPMENT

As detailed below, a scalable relational database has been created in the SIFIDS project that is, in principle, capable of accepting these data and undertaking automated analyses to generate a range of fisheries management and marine planning related outputs that could be made accessible in various levels of resolution to prescribed users.

This database currently resides on a secure USTAN server and its structure and function is detailed below. The database and Graphic User Interface (GUI) are designed to demonstrate the functionality of the prototypic data collection processes and systems developed under the SIFIDS project. The database and GUI have been developed using open source code and provide a platform for further development subject to requirements. The GUI outputs are largely generated using R-Shiny (https://shiny.rstudio.com/) and are exemplars of functionality and should not be regarded as a finished product for use in management of regulatory purposes.

Advanced Programming Interface (API) to link the tracker and the database

The open source API “Traccar” was used as the basis for forwarding data from the Teltonika tracking devices to the SIFIDS relational database. The Hypertext Pre-Processor (PHP) script referenced in the Traccar configuration is provided here:

https://github.com/StAResComp/sifids_web/blob/master/public/traccar2/index.php

The customisations to the Traccar code are these 3 lines in conf/traccar.xml:

```
<entry key='forward.enable'>true</entry>
<entry key='forward.url'>http://localhost/~sifids/traccar2/index.php</entry>
<entry key='forward.json'>true</entry>
```

A specification for the database could for example be:

Postgres 11.5 with PostGIS installed

Structure of the upgraded SIFIDS WP6 relational database

The schema and code for the relational database are available at the following link:

https://github.com/StAResComp/sifids_web/blob/master/db/sifids_db_schema.sql

GUI development to enable tiered access to the database together with example outputs

The Shiny app's code developed to help interrogate the SIFIDS relational database and display outputs can be found here:

https://github.com/StAResComp/sifids_web/tree/master/ShinyApps/app2

The GUI and selected database outputs

To further develop outputs from the SIFIDS Project WP6 “Development of a Pilot Relational Data Resource for the Collation and Interpretation of Inshore Fisheries Data”, the University of St Andrews researchers adapted the GUI interface to accommodate the data streams received from 1) Teltonika devices installed either directly to the vessels engine or powered by the prototypic solar panel box designed by USTAN, and 2) the On-Board Central Data Collation System (OBCDCS) developed by SeaScope under WP2a.

The following text and screenshots describe the current SIFIDS GUI for the relational database.

A tiered level of access was implemented through the GUI to allow different users access to variably aggregated or anonymised data. At the time of writing there are four levels of access: Admin, Researcher, Local Fishery Officer (FO) and Fisher.

The core pages of the interface available to all users were:

Home/Introduction page

Fish1 catch summary page

Track data page

Metrics

Historic Data

The administration level of access also displayed a “System Status” page.

Home Page

A page introducing the interface, displaying the logos of teams and the SIFIDS Project funding body (Figure 1).

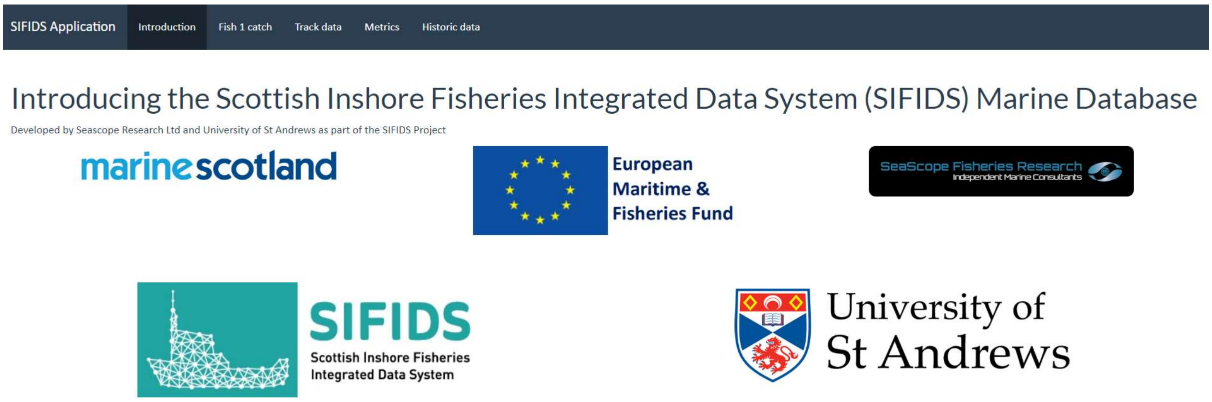

Figure 1. The home page of the SIFIDS online graphic user interface.

FISH1 catch

Data from the SIFIDS Work Package “Capture and Incorporation of Experimental Fisheries Data” (WP5) FISH1 mobile phone Application (FISH1 App) were sent to the University of St Andrews server and visualised on this page. The primary display showed two key summaries; the total weight of each species declared in the FISH1 forms submitted during the trial of the FISH1 App (See WP5 Final Report for more detail) in a table, and a graphic of the total weight for each species declared in submitted FISH1 forms in every week the trial ran (Figure 2).

Drop-down attribute lists that can selected to alter the data displayed:

Vessels

Between these dates

Port of departure

Port of landing

Fishery Office

Species

Data can be downloaded as comma separated value (csv) format using the download button seen in the bottom left of the screen.

Data entry and manipulation is dependent upon the level of access the allocated to the user. All users can select “Between these dates” and “Species”.

For Admin, the user can select all attributes and has an identifiable list of vessels to display (Figure 3). Researchers have the permission to select all attributes, however the list of vessels is anonymised (a letter is assigned to each vessel). For Fishery Offices, only Fishery Offices in their Marine Region[5] are listed, along with the vessels that submitted FISH1 forms to one of those fishery offices are visible. All other attributes can be edited. Fisher access only grants the fisher permission to see their own FISH1 data, therefore the Vessel drop-down list is disabled (unless that fisher has multiple boats, then only those vessels will appear). The fishery offices reported in that fisher’s FISH1 forms are available to select, along with the ports they have departed from, or landed catch.

A key aspect of the FISH1 data page was to demonstrate that various combinations of attributes can be used to refine the data produced. For example, if an Admin user only selects a Fishery Office then the vessel list will adjust to display all the vessels that reported to that office or, if a species is chosen, then only fishery offices, ports and vessels that were in FISH1 forms that contain that species will be available to choose from.

[5] http://marine.gov.scot/information/scottish-marine-regions

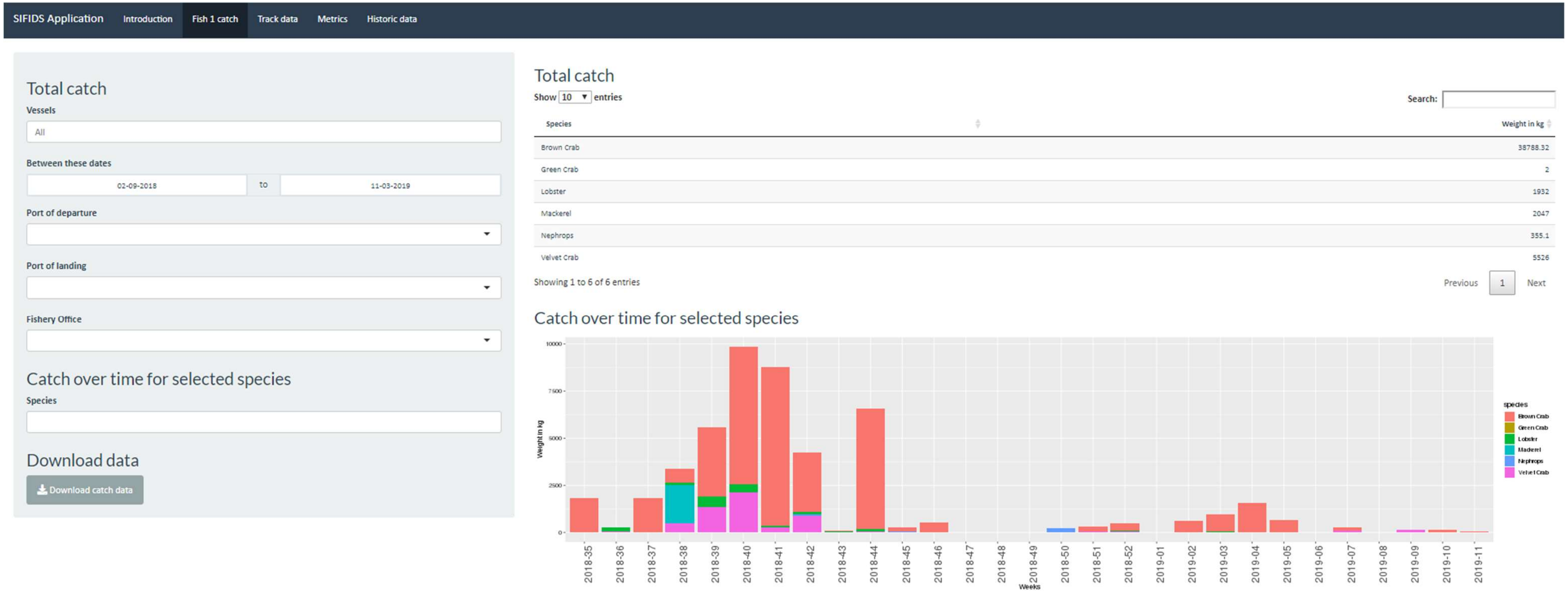

Figure 2. Researcher access to the FISH1 App data page, data from all vessels are summarised in the weight of species declared table and the catch over time for selected species bar chart, with different colours representing different species.

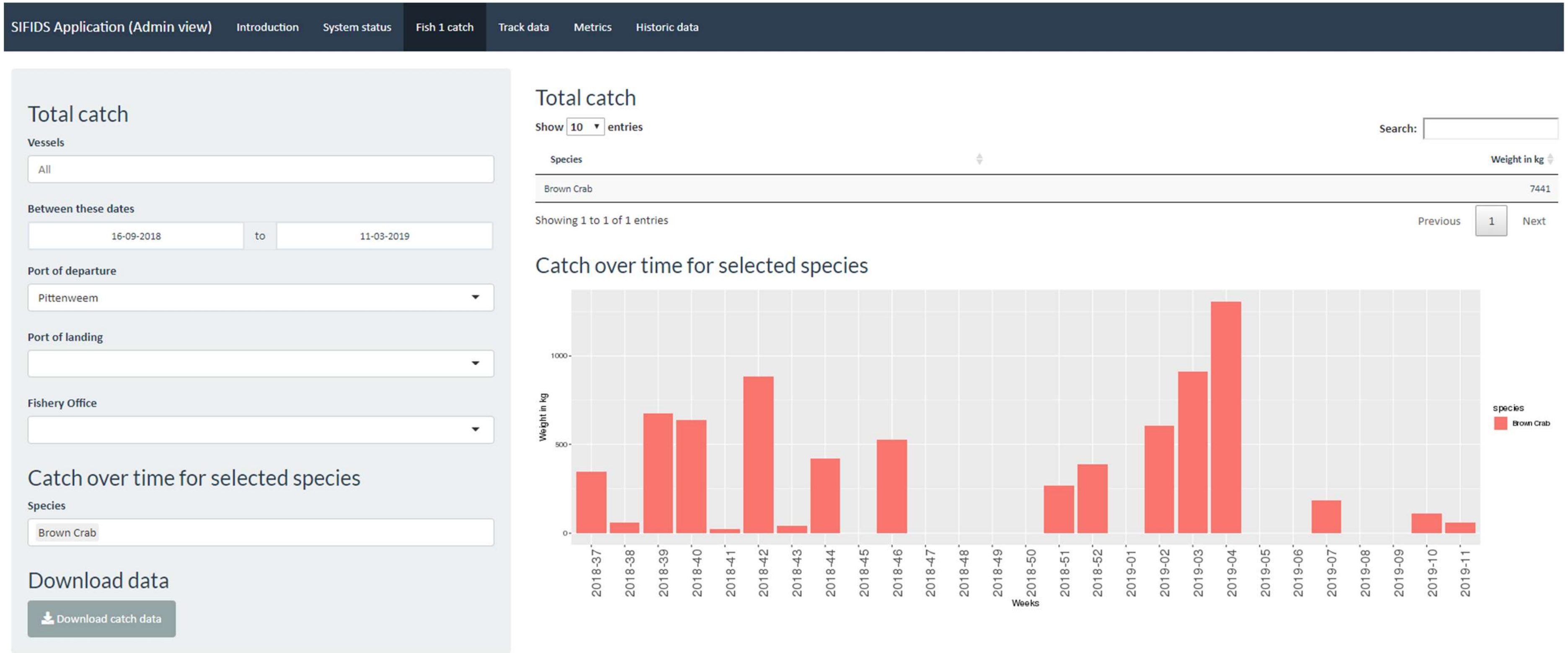

Figure 3. An example of data manipulation with researcher access to the FISH1 App data page displaying data from all vessels that recorded Pittenweem as the port of departure and reported lobster in their FISH1 form.

Track data

This page displays the historic and live tracks of all the vessels that volunteered to have tracking equipment or observers onboard their vessels. The user has the option to choose the type of map to display, the vessels to display (dependent upon the users level of access, and is concurrent with the permission described in the FISH1 data), the date range for the data, fishing events (when applicable) and a table of trips which the most recent at the top as shown by the date. Options selected will automatically refresh the data displayed in the trip table.

Track data was derived from onboard SeaScope researcher observations (see WP8a Final Report), the trialled SeaScope (OBCDCS) (see WP2a/b Final Report) and more recently, the Teltonika FMB202/204 devices that were either directly wired into the vessel's power or were solar powered. The OBCDCS logged a GNSS position every second, the sections of track that were not associated with predicted hauling activity was thinned to once every 30 seconds on the server to speed up the GUI as it displayed the track data. Sections of track data from the OBCDCS that were associated with predicted hauling activity were retained as one second records for the purposes of the trial (see WP8b report for more information). Teltonika devices were configured to log GNSS positions points every 60 seconds as this was determined to be the most efficient data recording resolution to infer fishing activity in static gear vessels.[6]

The user can select/deselect vessels and trip data from the table by clicking on rows in the trip table, each selected trip will be displayed on the map.

Under the objectives of WP8b, all track data gathered by the observers and OBCDCS were subsequently analysed to create predictive models of when hauling of pots onboard a vessel was occurring from a GNSS track data alone. From this, each analysed OBCDCS track displayed when hauling activity was predicted to have occurred and estimated the number of creels that may have been hauled (Figure 4a-b). The trip table displays the highest and lowest number of creels predicted to have been hauled in that specific trip, along with the estimated distance covered for the entire fishing trip.

The SIFIDS Project is currently updating the server's capacity to have a 24-hour refresh system whereby any new tracks received are analysed and hauling activity and creel numbers are predicted automatically. For vessels that had onboard gear sensors linked to the OBCDCS, the option to display recorded fishing activity is available. The vessel fishing events that could be displayed were "string haul", "string shoot" and "pot" (See SIFIDS WP6 report for further information).

Alternative formats to visualise the results of predicted hauling activity include kernel density heat maps and more spatially resolved (200m sq) repeat visit maps. The heat map displayed the predicted time spent hauling over a selected period in an aggregated format, the trip data table is disabled (Figure 5). Users can change the location and time period the heat map represents and the vessels displayed. The refinement of the heat map's detail improves as the user zooms in to a location. The revisits map displays data showing how often selected vessel(s) have re-entered 200m square areas when hauling has been predicted (Figure 6).

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[6] Mendo, T.; Smout, S.; Photopoulou, T.; James, M. (2019). Identifying fishing grounds from vessel tracks: model-based inference for small scale fisheries. Royal Society Open Science https://doi.org/10.1098/rsos.191161.
Mendo, T., Smout, S., Russo, T., D'Andrea, L., and James, M. (2019) Effect of temporal and spatial resolution on identification of fishing activities in small-scale fisheries using pots and traps. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsz073.

Users can change the time period the revisits represent and potentially the vessels displayed, the trip data table is disabled.

a

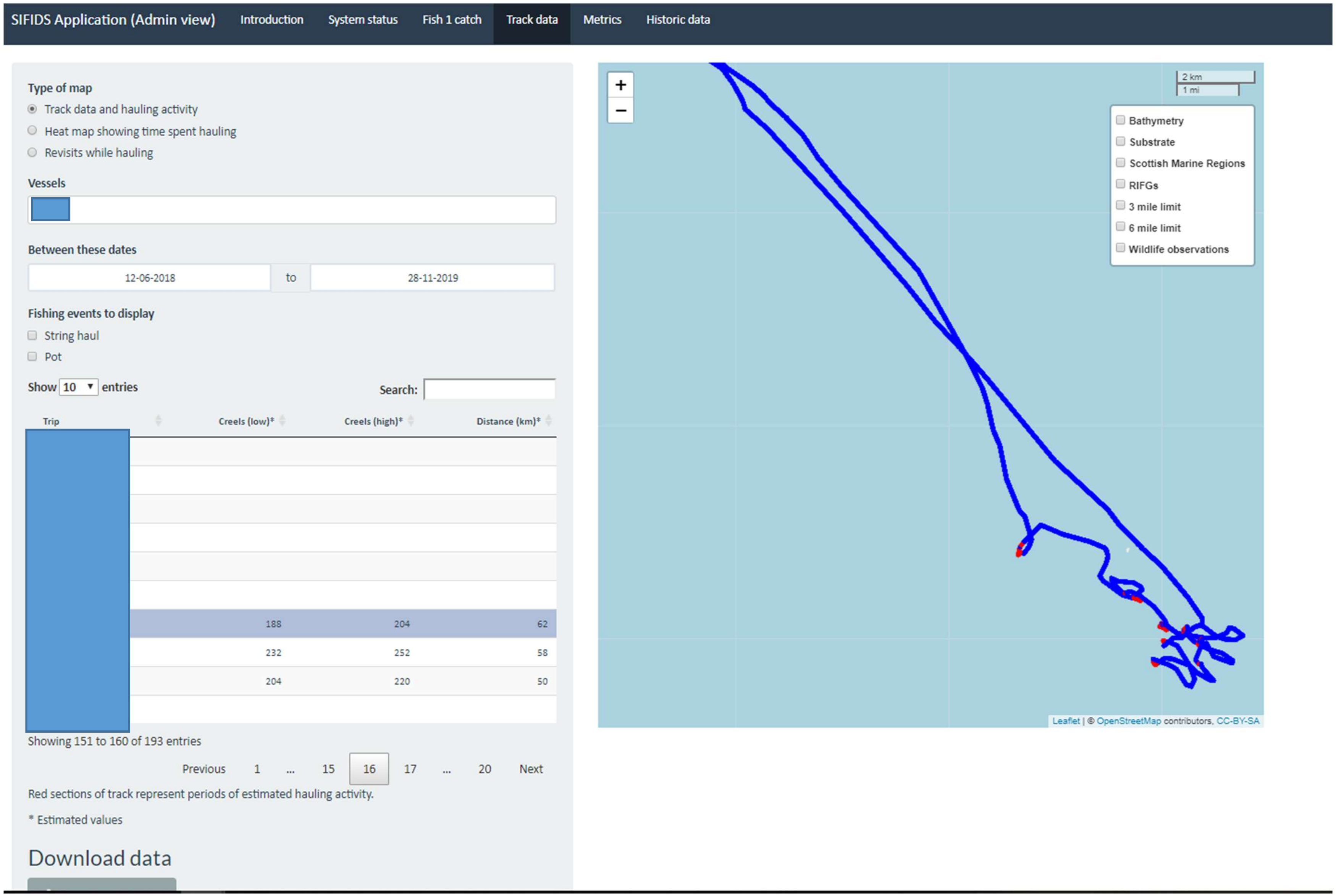


Figure 4a. A single vessel track (blue) produced by SeaScope's Onboard Central Data Collection System which has been subsequently analysed to predict when hauling activity occurred (red sections), the range number of creels that may have been hauled can be seen on the left-hand size. Blue squares are to anonymise the vessel. Lines without creel estimates are trips whereby the engine was turned on but did not leave the harbour.

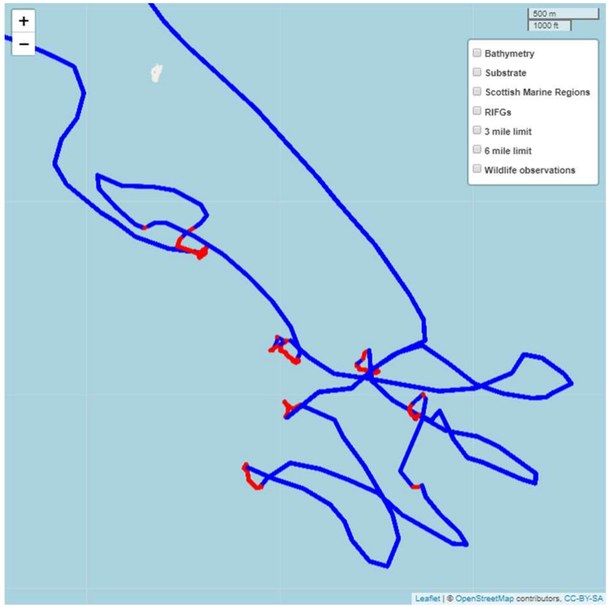


Figure 4b. A closer image of the track shown in figure 4a, the red areas where hauling is predicted to have happened.

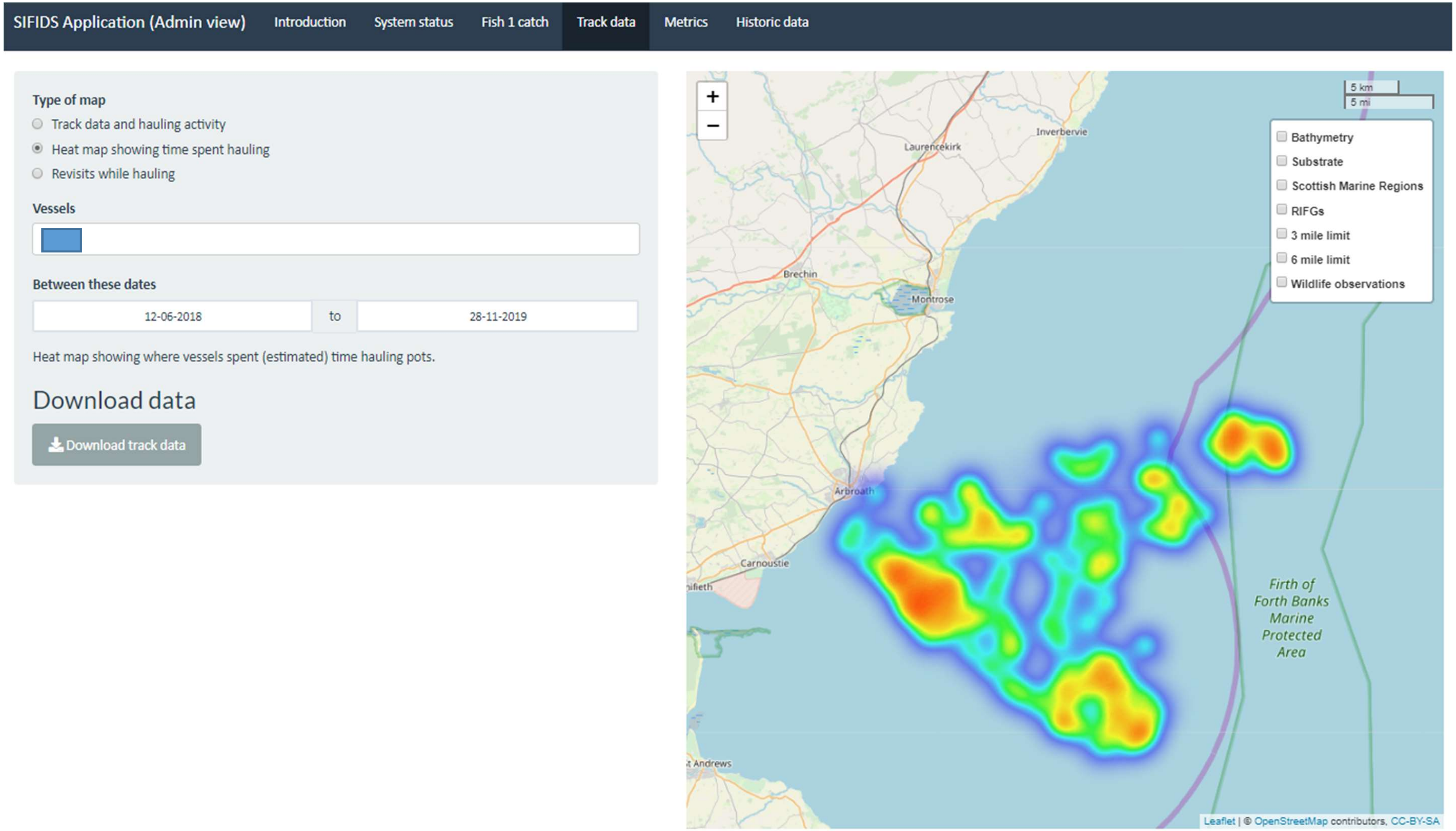


Figure 5. The heat map for the predicted hauling activity a selected vessel between 12/6/2018 and 28/11/2019. Red indicates a higher intensity of predicted hauling activity.

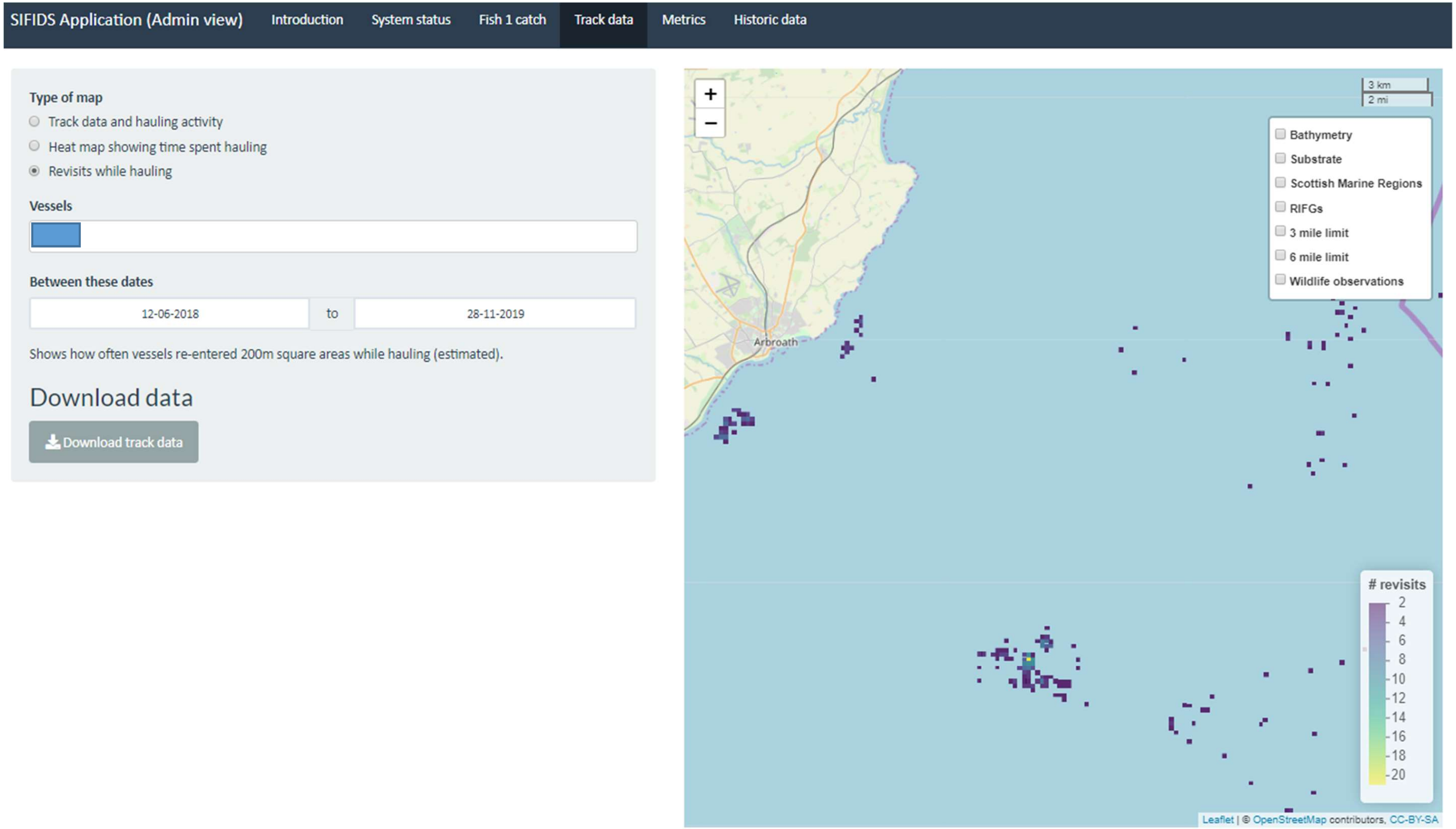


Figure 6. The revisit map for a selected vessel between 12/6/2018 and 28/11/2019. As shown in the key on the bottom right each 200 m square is coloured by how often the vessels has re-entered that 200m square whilst predicted to be hauling.

Additional static layers can be displayed together with maps and tracks selected (Figure 7). Layers include: Bathymetry, substrate, Scottish Marine Regions, RIFG areas, 2-mile limit, 6-mile limit and wildlife life observations submitted via the FISH1 App (see WP5 Final Report). Additional layers can be imported from a range of Geographic Information Sources.

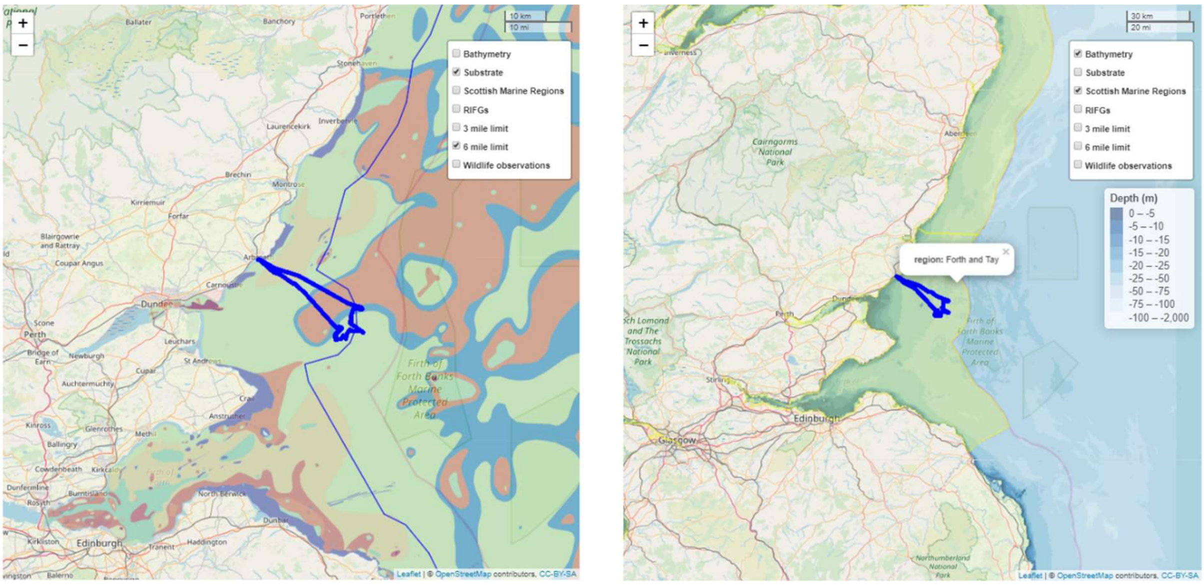


Figure 7. The same track with different combination of layers (left) the 6nmile limit and substrate layers are selected; (right) bathymetry data and Scottish Marine Region are selected.

Metrics

Example summaries of some fishing effort metrics can be generated and are displayed in three graphics on the Metrics page (Figure 8). Users can adjust the measure of effort by selecting one of the following options:

Distance travelled per week (km)

Creels used per week (estimate)

Trips per week

The bottom two graphs do not change unless the user changes the vessel(s), time period and species.

The measures of effort are the result of combining FISH1 data provided to the SIFIDS Project by Marine Scotland (after being granted permission by fishers) with WP8b's statistical models predicting hauling time and number of creels hauled, and the GNSS tracks gathered by either the onboard observers or the OBCDCS.

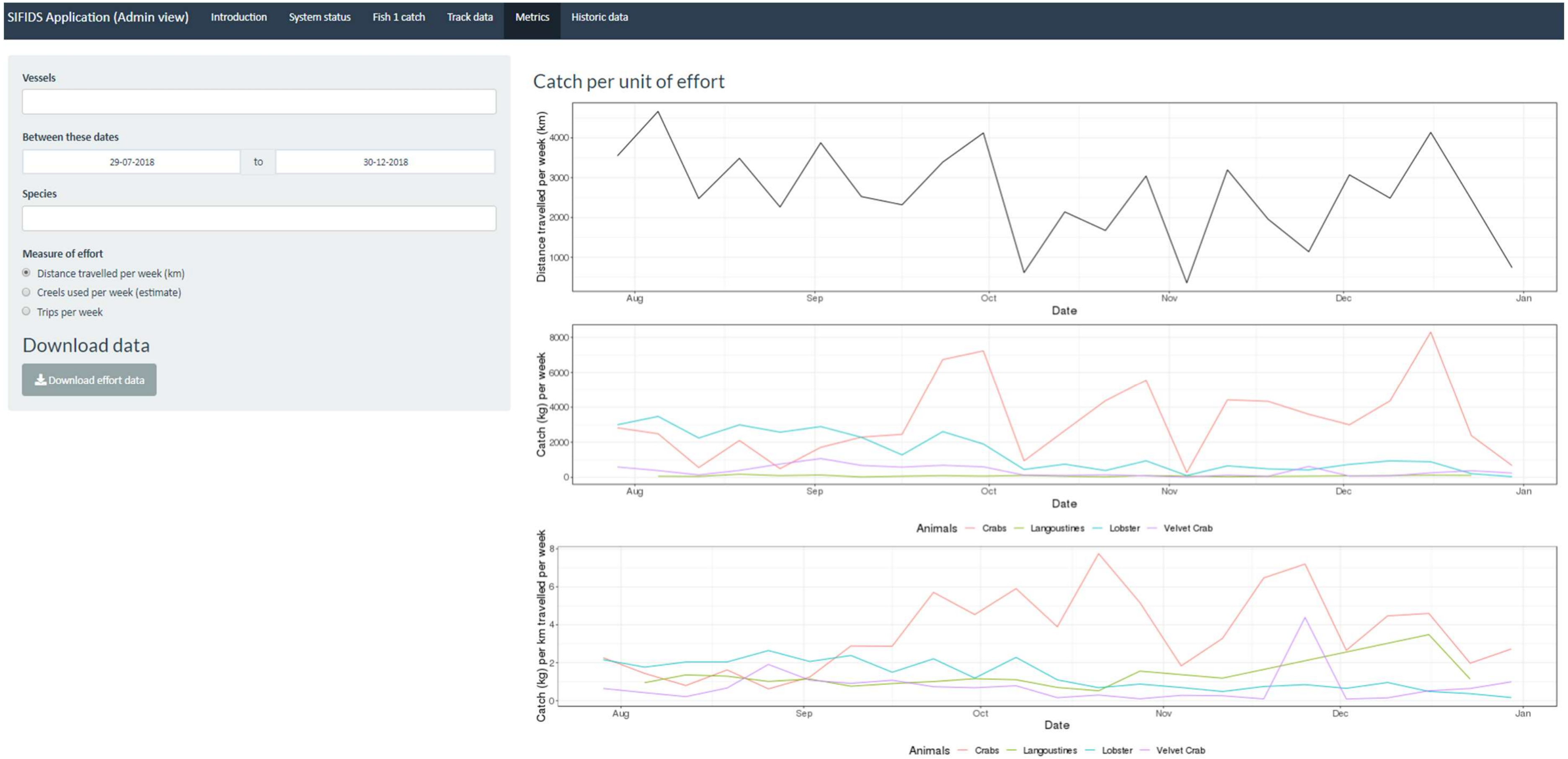


Figure 8. The Metrics page displaying all three catch per unit graphics produced for the entire fleet analysed.

Historic data

Static data drawn in from external sources were uploaded onto the server to demonstrate the capability of the GUI to host and display data in an interactive format (Figure 9). The layers can be overlaid allowing the user to stack data on the map. The map on the Historic Data page is separate to the Track Data page.

Data available and sources:

Hauls per Day (ScotMap data)

Source: https://www2.gov.scot/Resource/0046/00466802.pdf

Reference: Kafas, A., McLay, A., Chimienti, M. and Gubbins, M., ScotMap Inshore Fisheries Mapping in Scotland: Recording Fishermen's use of the Sea. Scottish Marine and Freshwater Science. Volume 5 Number 17

Vessels with Creels

Source: http://marine.gov.scot/information/creel-fishing-effort-study

Reference: Marine Scotland Science, 2017, Creel Fishing Effort Study, Scottish Government

Creel sightings

Selectable years: 2008, 2009 and 2010

Source: Hebridean Whale and Dolphin Trust

Minke Strandings

Data presented through the SIFIDS user interface show the location of stranded Minke whales that were identified as having been entangled from 1990 to 2018.

Data source: Scottish Marine Animal Stranding Scheme (2019)

Time period: 1990 to 2018

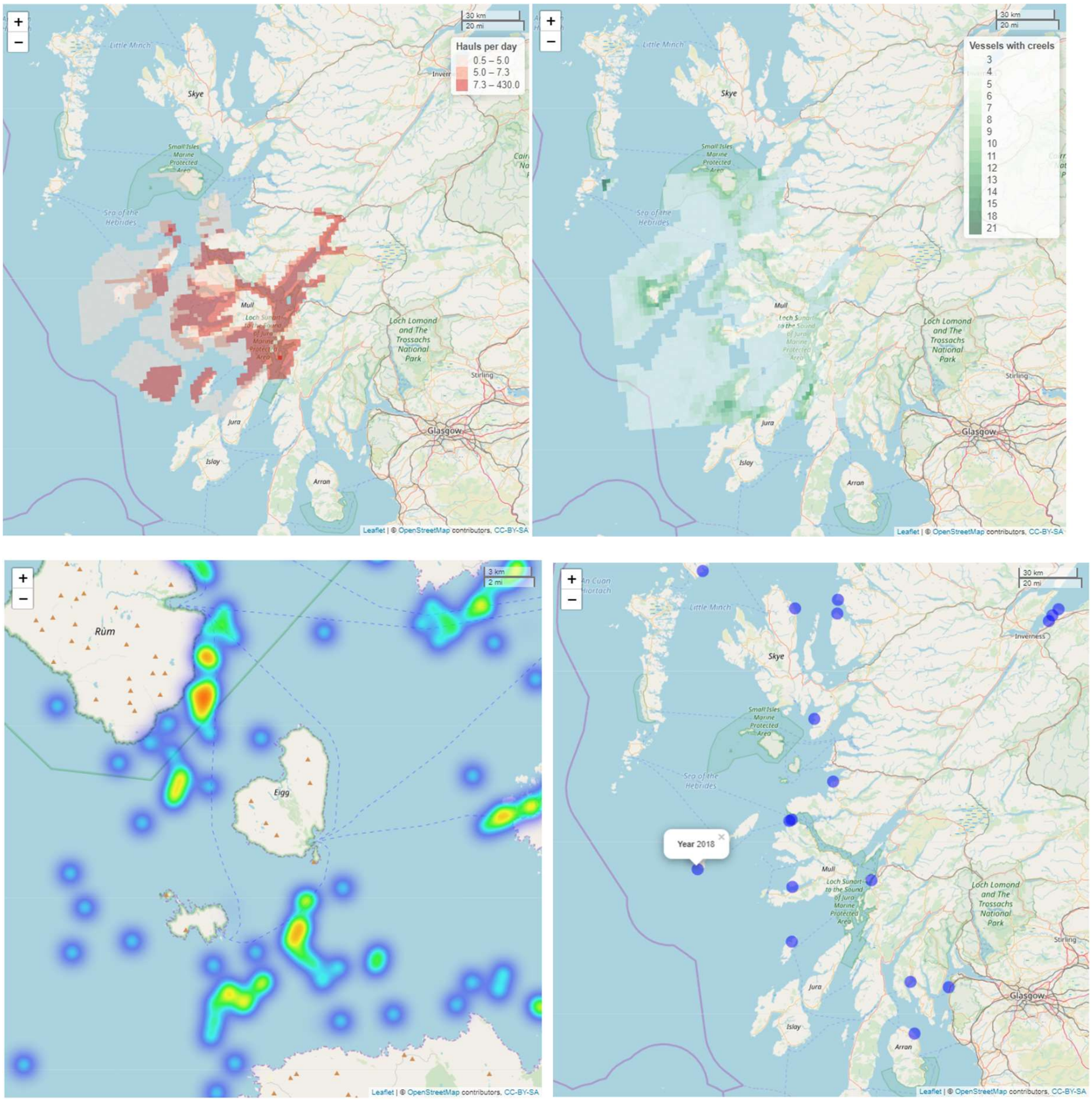


Figure 9. The four different layers on the Historic data page (top left) Hauls per day (ScotMap data)**; (top right)** Vessels with creels**; (bottom left)** Creel sightings**; and (bottom right)** Minke Strandings with one bubble selected showing the year of sighting.

<u>Administration access</u>

System Status page

Administration log in gives the user complete, unrestricted access to data accessible through the interface, including the admin-only “System Status” page. The page is a diagnostics page for every Teltonika device supplying data to the server. Attributes that can be selected to analyse the performance of one or multiple devices are:

Power to device (volts)

Distance of trip/day (km)

Total distance covered by vessel (km)

Number of visible satellites

Charge of internal battery device (volts)

Upon selecting an attribute, time period and vessel(s), graphical displays are generated (as an example see Figure 10).

The data displayed is automatically logged by each device and does not require additional software configuration to obtain the information. Configuration of a device can be achieved remotely through the Teltonika Configurator program[7], updates can be created and sent via short message service (SMS) protocols to selected or multiple devices. The update will be complete once the device is turned on and connected to a mobile phone network. Updates can include firmware, adding geo-fences, the frequency at which the device logs its position or reports to the server. The satellite constellations the device should interrogate, wake and sleep cycles together with accelerometer sensitivity and many other attributes can be remotely configured. With respect to geofences, use of the Teltonika's thus far, would suggest that complex polygonal geofences will need to be accommodated either through server side programming and subsequent alerts generated by the server or additional programming of the Teltonika's. Low battery and anti-tamper related alerts which would be available to administrators of the system would need to be implemented as part of the database functionality, but this would be a relatively straightforward addition.

[7] https://wiki.teltonika.lt/view/Teltonika_Configurator_versions

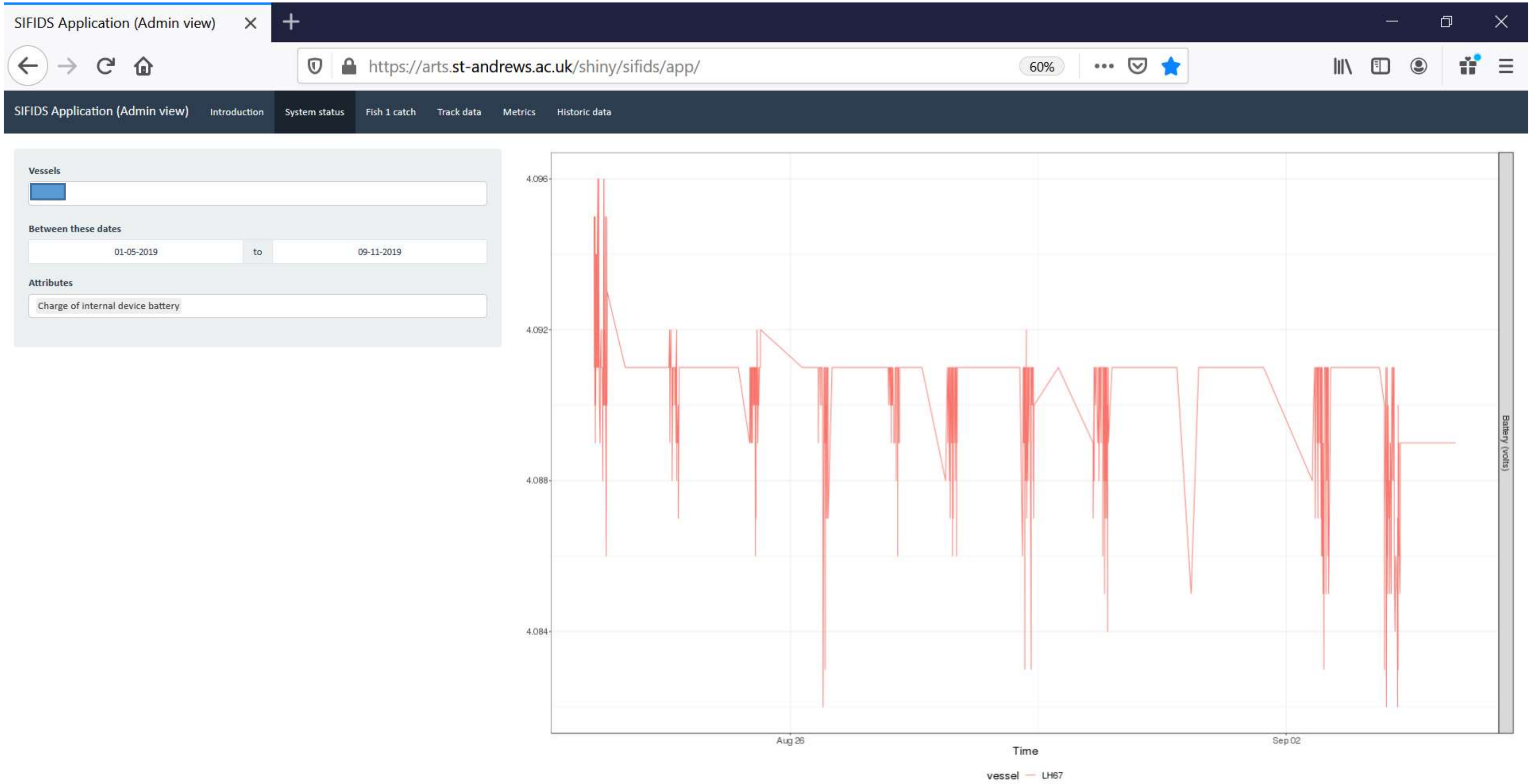


Figure 10. The system status page, only accessible with in Admin log-in details, displaying a selected vessel's (PLN hidden) "change in internal device battery" as one of the five potential Attributes that can be selected.

ANNEX 1 – TELTONIKA COST ESTIMATES

The Teltonika FNB204 unit can, at the time of writing, be purchase from a UK agent for ~£65 + VAT

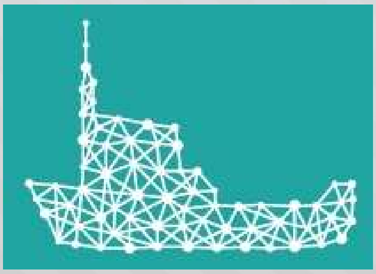
The addition of a multi-SIM card such as Truphone has an annual cost of ~£15

The cost of the initial configuration of the devices and fitting of the SIM cards varies with the number, but we have been quoted £50 for the configuration of 200 units.

Under the current arrangement with the UK agent for these devices and SIM cards, it is possible to link the accounts and data usage to allow the data allowance from those using less than their allocated quota to be transferred to those using in excess of their allocated allowance to further reduce the cost.

Table 1. illustrates the data use of a number of active fishing vessels currently fitted with Teltonika FMB204 devices. The data is in Mb unless marked as Kb

	Oct	Nov	Dec
	Mb		
+447408818760	12.73	6.67	14.25
+447408817923	1475Kb	976kb	0
+447408819501	1.08	0.35	0
+447408818934	1078kb	2905kb	3338kb
+447408818013	9.87	15.61	16.11
+447408818419	0	17.02	13.38
+447408818641	0	22.76	21.55
+ 447408957598	592kb	48kb	0
+447408868957	11.26	17.88	10.36
+447408818385	0	936kb	0



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