Linking Ocean Governance to Real World Challenges

Monitoring and management - using small scale fisheries as an example

Ocean Governance in Archipelagic Regions – 7-10 Oct 2019

University of St Andrews

CRMG
Coastal Resources Management Group

European Maritime & Fisheries Fund

SIFIDS
Scottish Inshore Fisheries Integrated Data System

International ocean governance:
EU agenda for the future of our oceans! 2019

Priority areas:

- *Improving the international ocean governance framework;*
- *Reducing human pressures on the oceans and creating the conditions for a sustainable blue economy;*
- *Strengthening international ocean research and data.*

EU's response to the **United Nations' 2030 Agenda for Sustainable Development, SDG14**

- 'to conserve and sustainably use the oceans, seas and marine resources'.

- 60% of oceans are outside national jurisdiction. Covered by UN Convention on the Law of the Sea – complex outdated? SLOW!

- **EU Integrated Maritime Policy**;
- **EU-level strategy to boost sustainable and inclusive blue growth**,
- **EU Maritime Security Strategy**

CO2 Levels: Current & Historic | Special Report on the Ocean and C

https://www.ipcc.ch/srocc/home/

Search

MENU ipcc ABOUT RESOURCES DOWNLOAD REPORT SEARCH

FOLLOW

SHARE

REPORT HOME SUMMARY FOR POLICYMAKERS

Special Report on the Ocean and Cryosphere in a Changing Climate

The IPCC approved and accepted *Special Report on the Ocean and Cryosphere in a Changing Climate* at its 51st Session held on 20 – 23 September 2019. The approved Summary for Policymakers (SPM) was presented at a press conference on 25 September 2019.

GO TO THE DOWNLOAD PAGE

ENG 05/10/2019

GLOBAL CO_2 LEVELS

Click and drag in the plot area to zoom in

Powered by the 2 Degrees Institute


GLOBAL CO_2 LEVELS
Reset zoom
0.9°C
CARBON DIOXIDE (CO_2 PPM)
TEMPERATURE ANOMALY (°C)
432
420
408
396
384
372
360
348
336
324
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
1980
1985
1990
1995
2000
2005
2010
2015
"Believing in sustainability and stopping climate change BUT .....living and working in ways that are not compatible with that belief"
Powered by the 2 Degrees Institute

WHAT DOES IT MEAN? –
20 Countries have declared Climate Emergencies !

Climate emergency declarations in 1,087 jurisdictions and local governments cover 266 million citizens

Posted on *3 October 2019*

1,087 jurisdictions in 20 countries have declared a climate emergency. Populations covered by jurisdictions that have declared a climate emergency amount to 266 million citizens, with 47 million of these living in the United Kingdom. This means in Britain now roughly 70 per cent of the population lives in areas that have declared a climate emergency. In New Zealand, the percentage is even higher: 74 per cent of the population. It's around 25 per cent in countries like Switzerland and Italy.

- The need for this report: "Pervasive ocean and cryosphere changes…are already being caused by human-induced climate change."
- High mountain areas: Glaciers could lose a fifth of their mass this century if emissions are low, and more than 80% in regions such as Central Europe.
- Sea ice: There is "very high confidence" that Arctic sea ice has declined in all months of the year and around half the summer loss is due to human-caused warming.
- Ice sheets: Greenland melt is unprecedented in at least 350 years. With rising Antarctic loss, ice sheets are now contributing 700% more to sea levels than two decades ago.
- Implications of polar warming: Polar bears are travelling further due to less ice, while Arctic peoples and marine life face rising negative impacts due to warming.
- Abrupt changes and 'tipping points': The AMOC ocean current that brings warm water to Europe may already have weakened by 15%, but is "very unlikely to collapse" this century.
- Permafrost: Arctic near-surface permafrost faces "widespread disappearance", with a 30-99% decrease in area if emissions are very high, releasing 10s to 100s of billions of tonnes of CO_2.
- Sea level rise: The rate is accelerating and is "unprecedented" over the past century. Worst-case projections are higher than thought and a 2m rise by 2100 "cannot be ruled out".
- Impacts for coasts and islands: Warming could "drastically alter" migration flows. If emissions are high, some island nations are "likely" to become "uninhabitable" this century.
- Marine life: Marine mammals could decline by 15% and fisheries by a quarter this century, if emissions are very high, while "almost all coral reefs will degrade" even if emissions are low.
- Extreme events: Cyclones, marine heatwaves and other extremes are becoming more severe and will exceed the limits of adaptation, causing "unavoidable loss and damage".
- Socioeconomic implications: Changes to oceans and the cryosphere will impede the UN's sustainable development goals and could expand the range of disease threats.

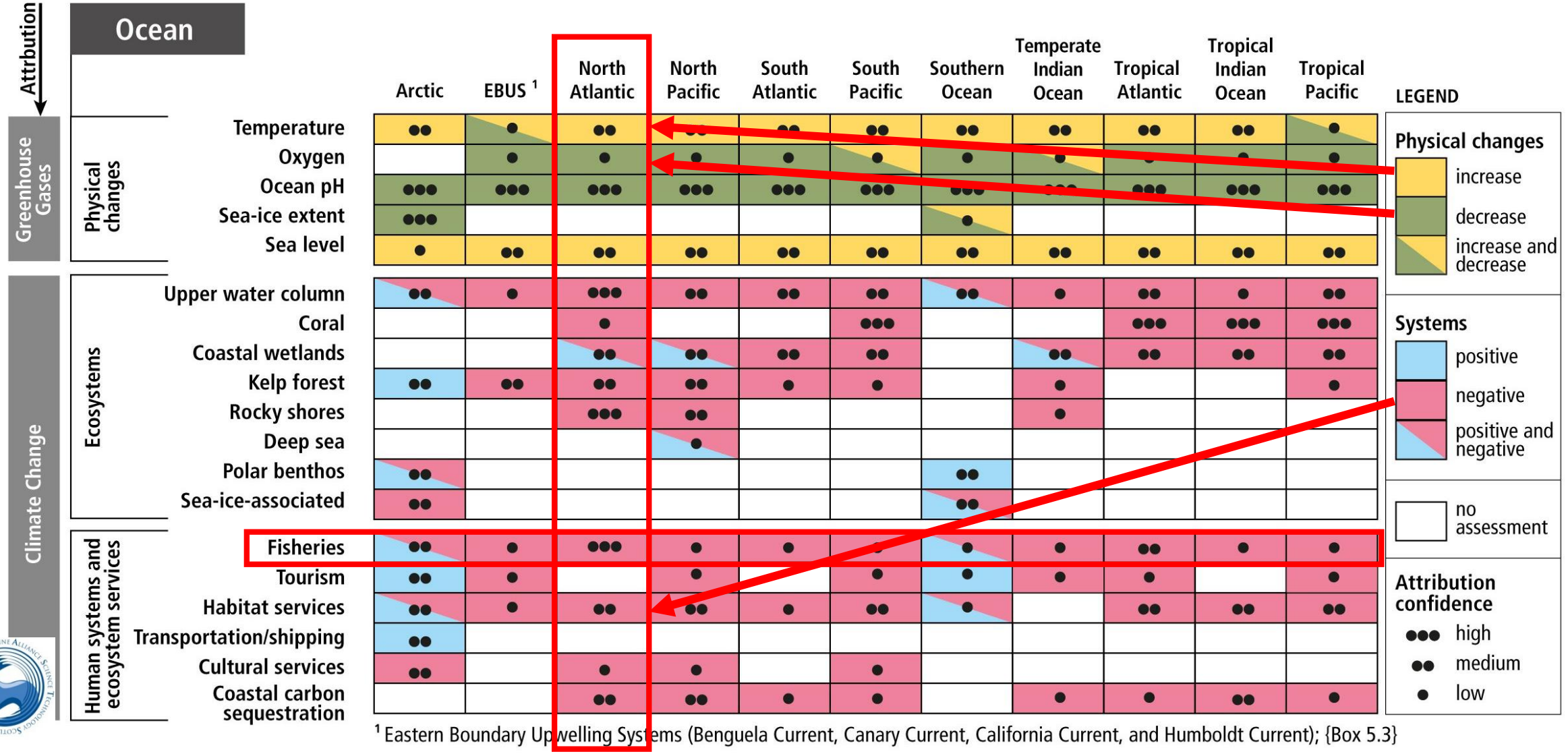
Marine Alliance Science Technology Scotland

University of St Andrews

CRMG Coastal Resources Management Group

Observed regional changes in the ocean (IPCC SROCC 2019)

Scottish Government
Riaghaltas na h-Alba
gov.scot

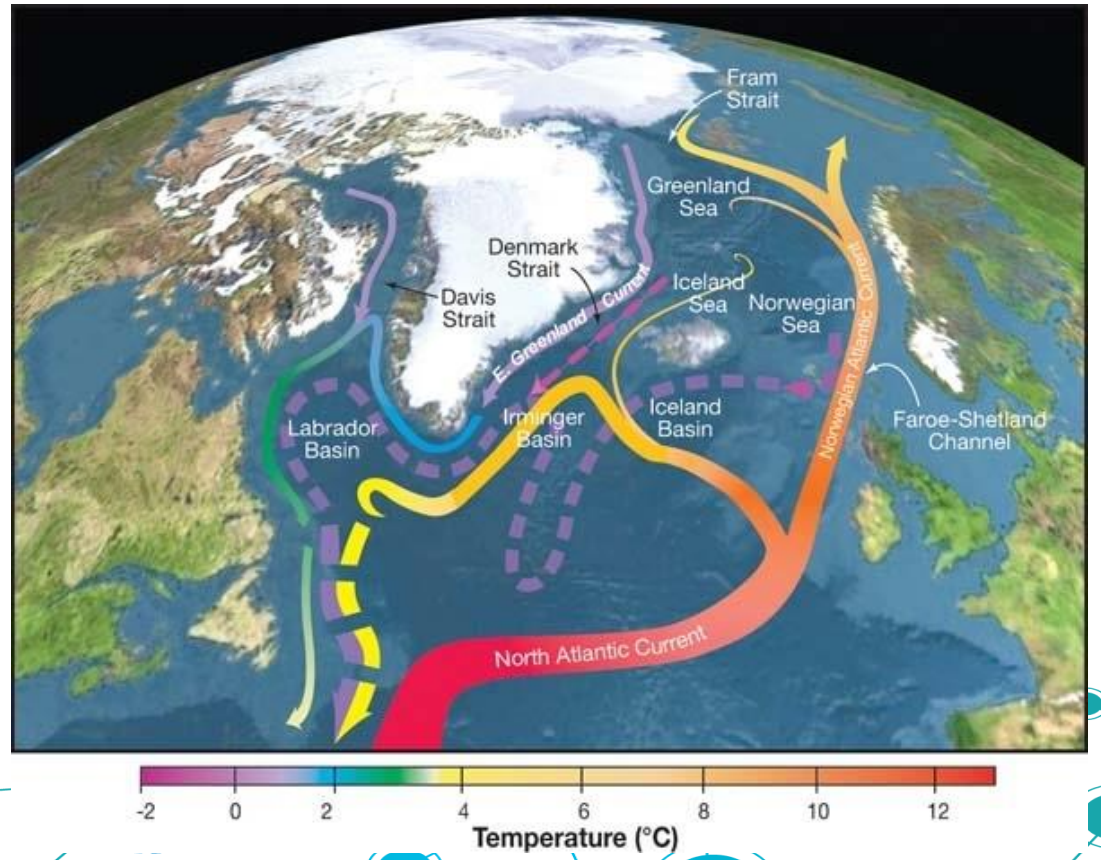


WHAT DOES IT MEAN?

Comforting?

- Abrupt changes and 'tipping points': The AMOC ocean current that brings warm water to Europe may already have weakened by 15%, but is "very unlikely to collapse" this century.

Atlantic Meridional Overturning Circulation



WHAT DOES IT MEAN?

- Sea level rise: The rate is accelerating and is "unprecedented" over the past century. Worst-case projections are higher than thought and a 2m rise by 2100 "cannot be ruled out".
- Impacts for coasts and islands: Warming could "drastically alter" migration flows. If emissions are high, some island nations are "likely" to become "uninhabitable" this century.

Coastal cities - high risk - costly flooding as sea levels rise - current defenses will not be enough.

Flood damage to large coastal cities could rise to $1 trillion a year

Human migration as a result of climate change is now a reality. Africa, Asia and Latin America - moving in response to unpredictable rainfall patterns. The governments of Bangladesh, Papua New Guinea and small island states, resettling people because of rising seas.

150m Climate Refugees

WHAT DOES IT MEAN?

- Marine life: Marine mammals could decline by 15% and fisheries by a quarter this century, if emissions are very high, while "almost all coral reefs will degrade" even if emissions are low.

WHAT DOES IT MEAN?

- Extreme events: Cyclones, marine heatwaves and other extremes are becoming more severe and will exceed the limits of adaptation, causing "unavoidable loss and damage".

WHAT DOES IT MEAN?

- **Socioeconomic implications:** Changes to oceans and the cryosphere will impede the UN's sustainable development goals and could expand the range of disease threats.

If children want to protest against ...
spectator.co.uk

Youth climate change protests across ...
theguardian.com

Youth-led climate protests sweep across ...
grist.org

Academics back UK schools' climate ...
theguardian.com

Climate strike: Schoolchildren protest ...
bbc.com

Thousands of UK school children protest ...
rnz.co.nz

Climate change activists vow to step up ...
theguardian.com

I saw climate change hell in the Thom...
latimes.com

Climate strike: Schoolchildren protest ...
bbc.com

Thousands of scientists are b...
nature.com

Fridays for Future: Students hold ...
dw.com

Students protested around the globe for ...
npr.org

In Brussels, students skip school for ...
euractiv.com

WHAT DOES THIS MEAN FOR SSF?

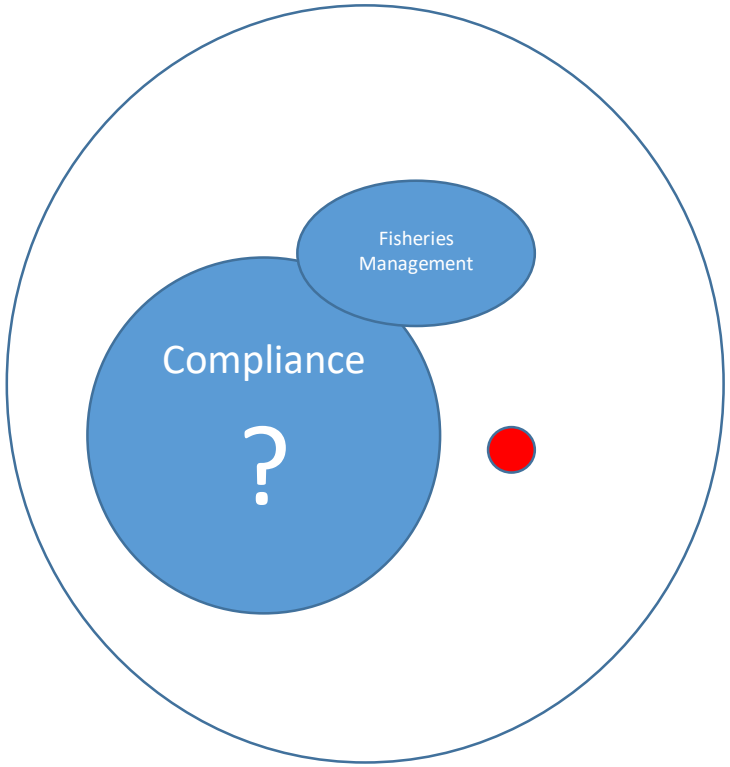
- 96% of fishers around the world are artisanal or small-scale
- account for ~ 35% of the fish caught worldwide,
- ~90% of the catch for small island developing States
- 50 to 90% of the protein consumed in small, vulnerable economies comes from fish caught by small-scale artisanal fishers (global average of 17%).
- Jobs and food for billions of people in vulnerable communities

- **On the front line of climate and global change**

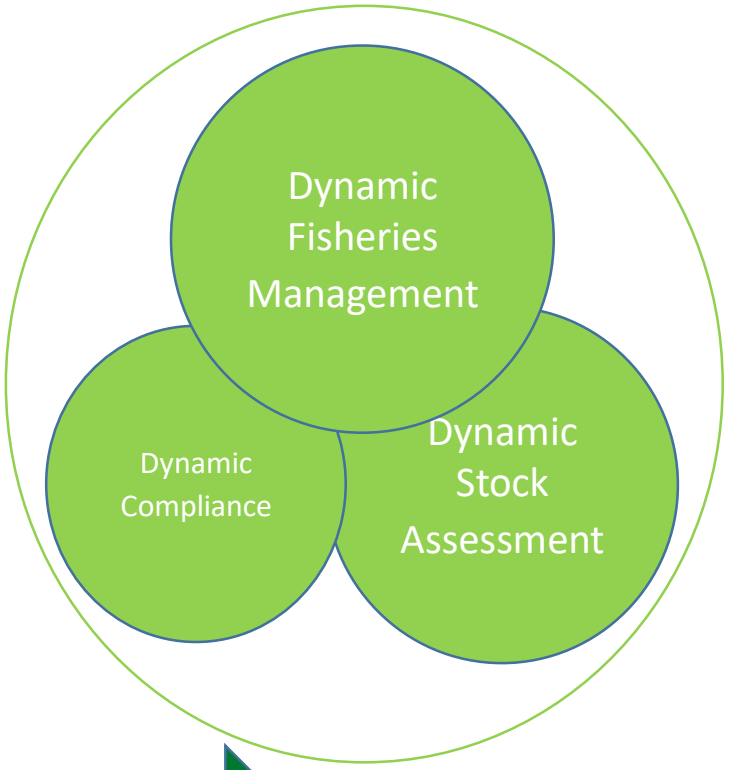
Artisanal fishery – Organos, Peru - 2019

What role can science play?

Today – Top Down
Little feedback or incentive for co-management



Where we need to be ASAP
Lots of feedback and incentives for co-management



DATA + RAPID ADAPTIVE MANAGEMENT

Stock Assessment

Key Principles of the Project

- Collect useful, relevant data from fishing vessels and fishers
- Maximise the automation of data collection, collation and analyses
- Use Open Source solutions – software and code free of copyright
- Utilise low cost available or adaptable technologies
- As far as possible future proof systems and processes by making them flexible and adaptable

SIFIDS
Scottish Inshore Fisheries Integrated Data System

Challenging conventional wisdom! - Fishers will never willingly be tracked!

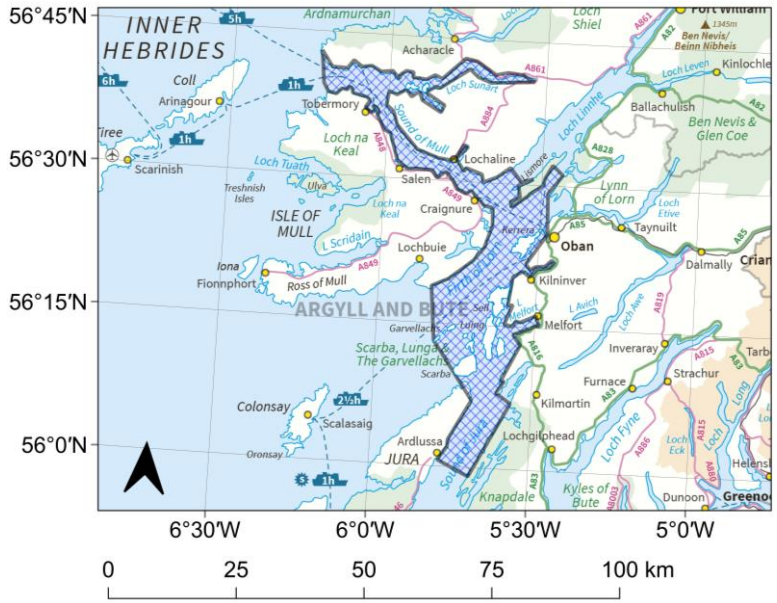
Fishers required to:

- demonstrate sustainability and compliance – they need data*
- provide evidence to support claims of space use and value in the face of marine spatial planning challenges – they need data*
- support/defend accusations of gear conflict – they need data*
- provide evidence of provenance/traceability for accreditation schemes – they need data*
- improve the efficiency of their businesses – they need data*

**independently verifiable data*

MSP Challenges to SFF

MPAs

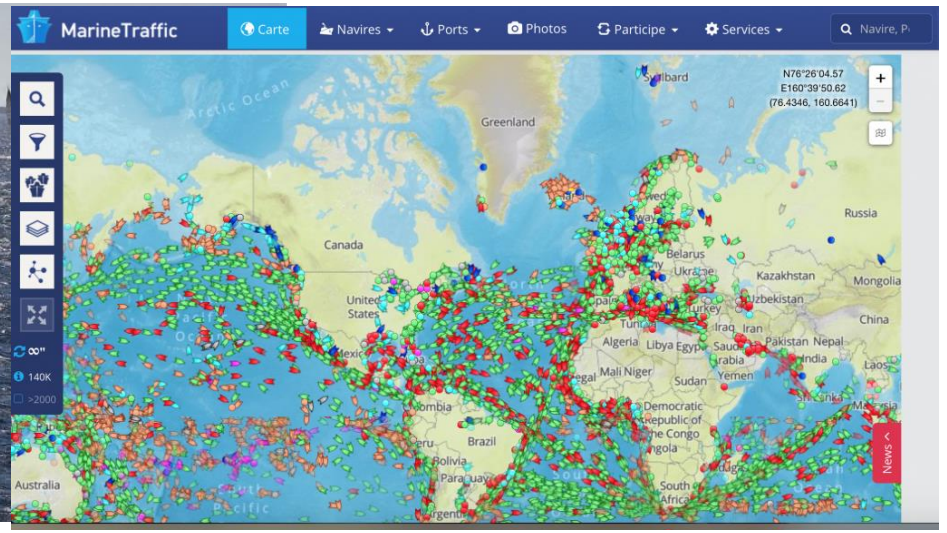


Marine Renewables

Aquaculture

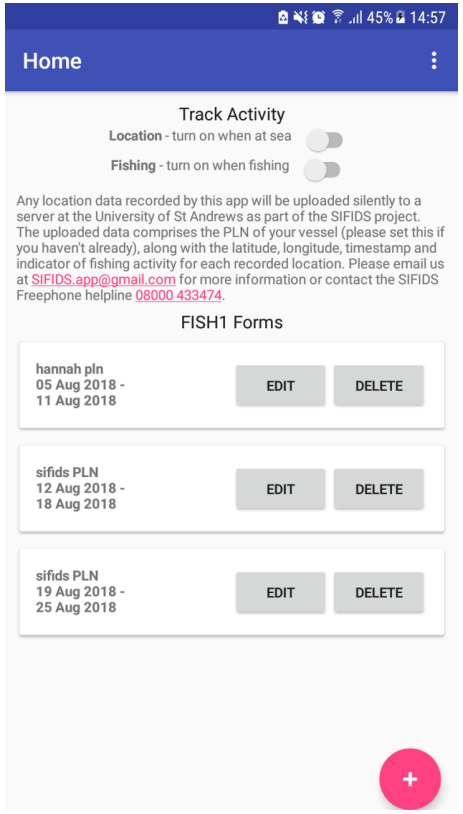
Leisure

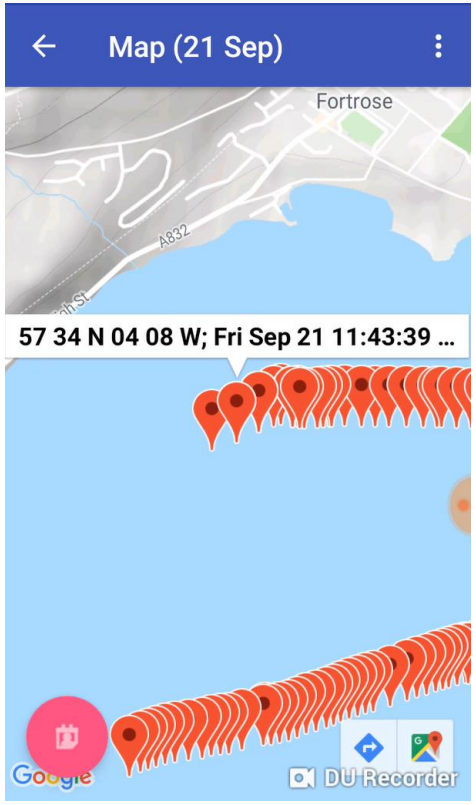
Marine Traffic

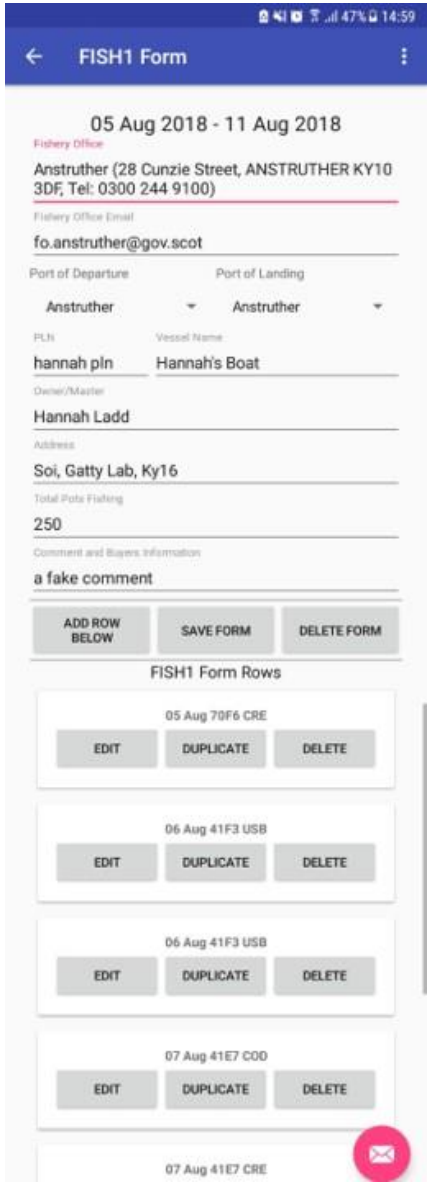


Wearmouth & Sims (2009); Neat et al. (2014); Map produced by Edward Lavender in QGIS using Ordnance Survey data © Digimap (2017)

The SIFIDS App – Basic biological (catch data)





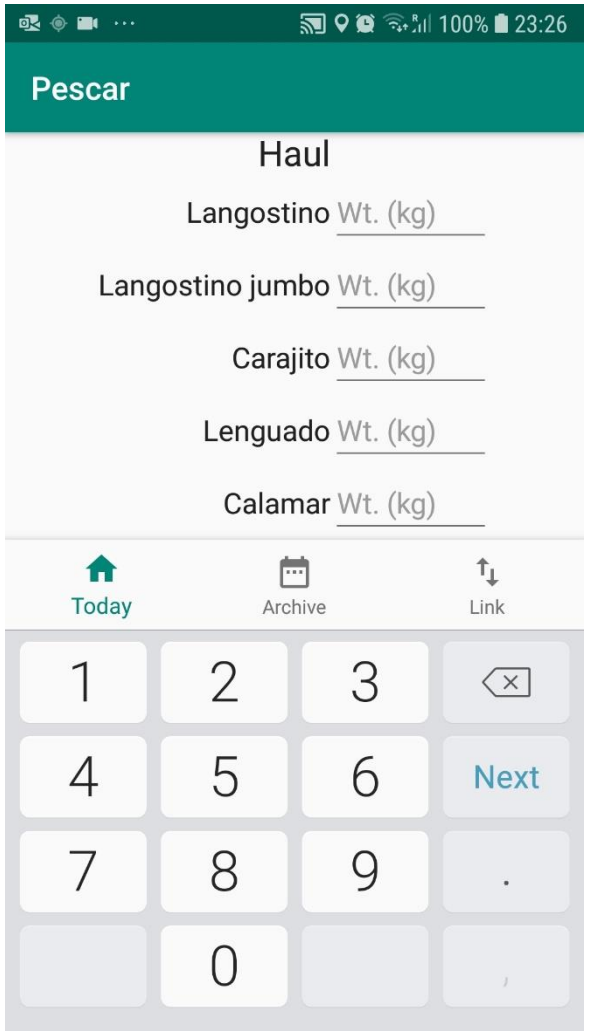


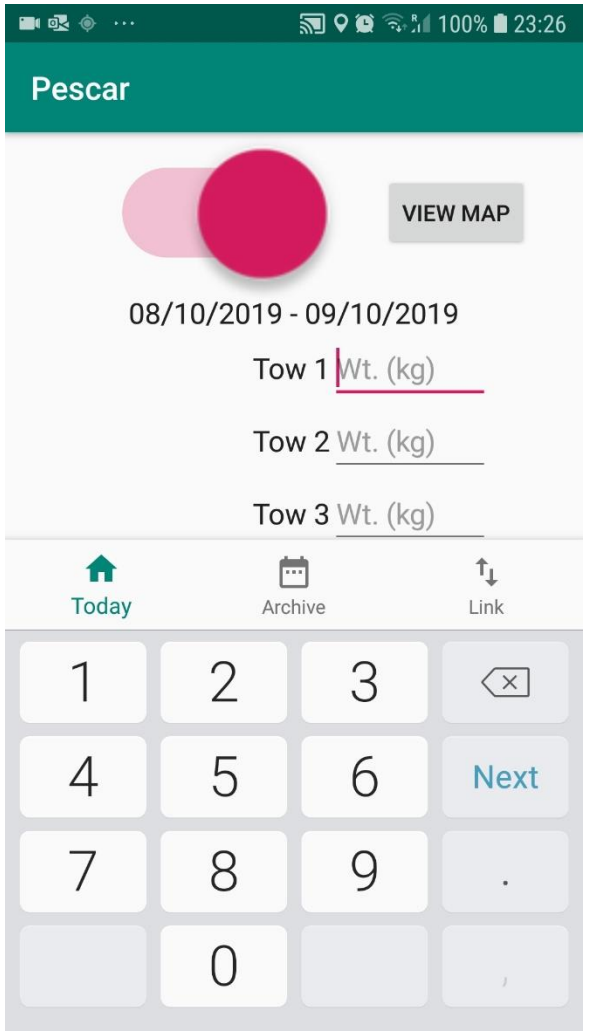
Home page

Key features:

- In app tracker
- FISH1 form submission
- Wildlife logger
- Stored settings for personal details

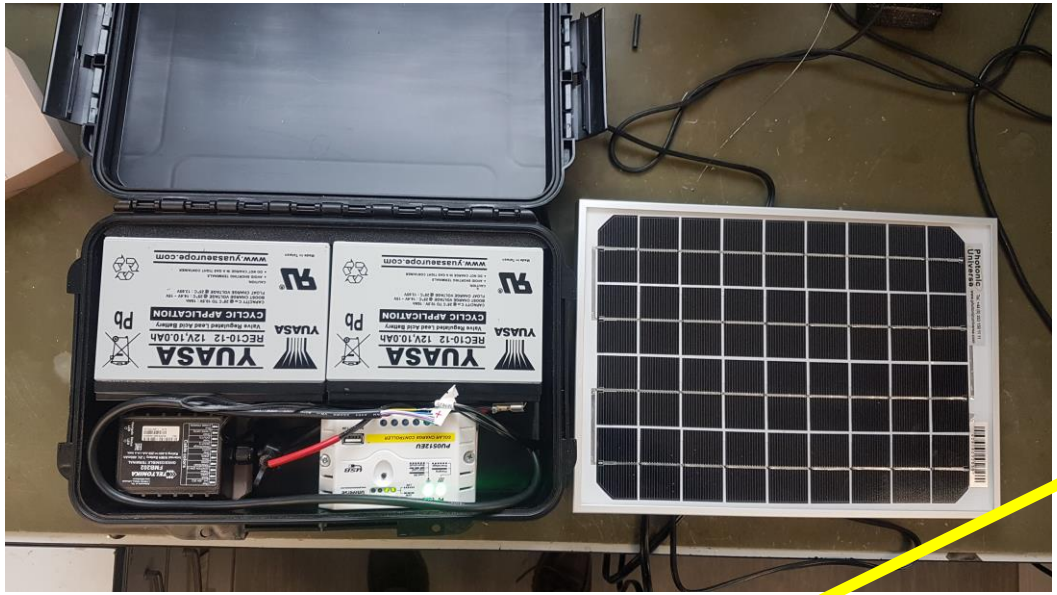
Derivation of App – being used in Peru

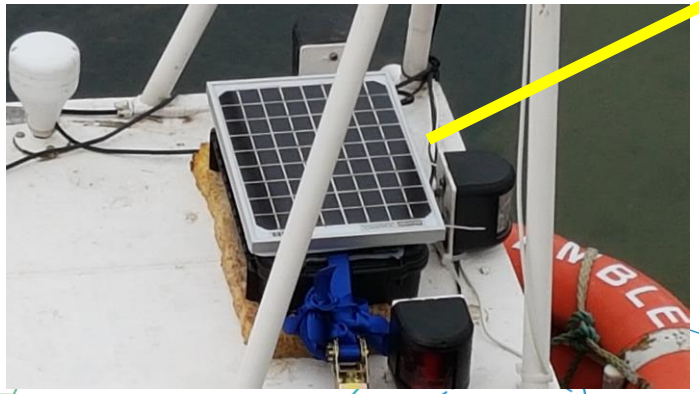




USTAN equipment in the field – solar tracker 10W (version one)

Just GNSS tracks





10W Solar Tracker – functioning independently for >8 months

SIFIDS
Scottish Inshore Fisheries Integrated Data System

SOLAR Tracker 5W (version two) – to be fitted to polarlys 5m vessel

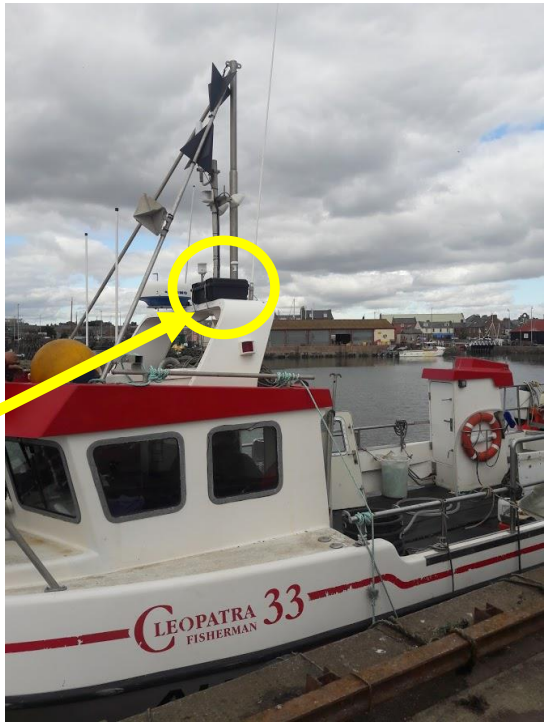
24cm

Cost <£300

SIFIDS
Scottish Inshore Fisheries Integrated Data System

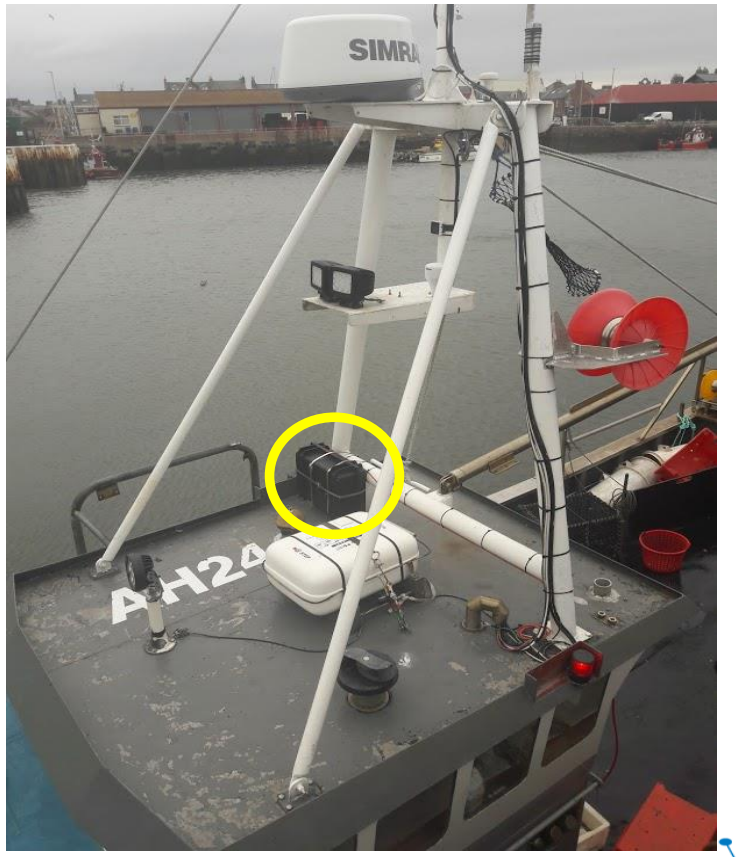
Seascope In the field-On Board CENTRAL data collection system (OBCDCS)

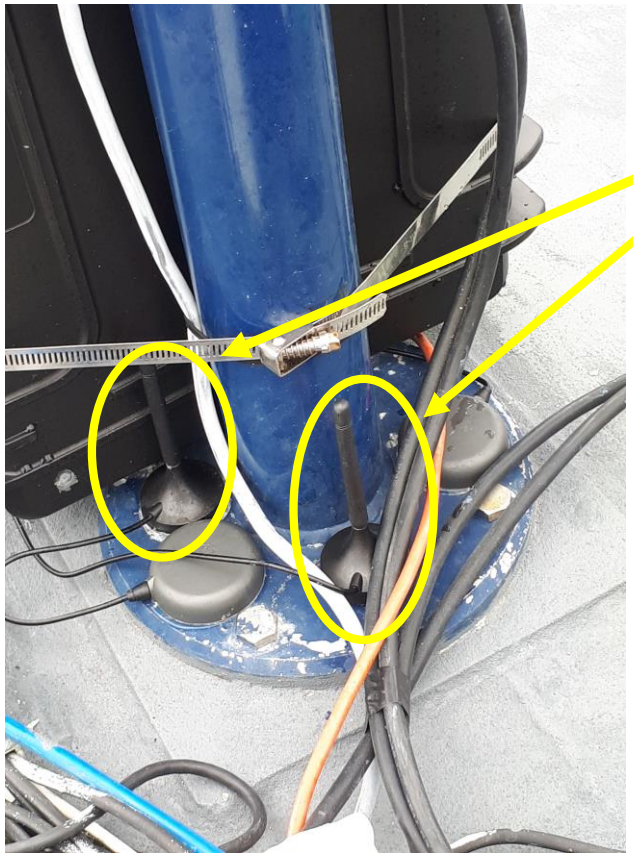
The OBCDCS collects track data and other data streams like winch use



SIFIDS
Scottish Inshore Fisheries Integrated Data System

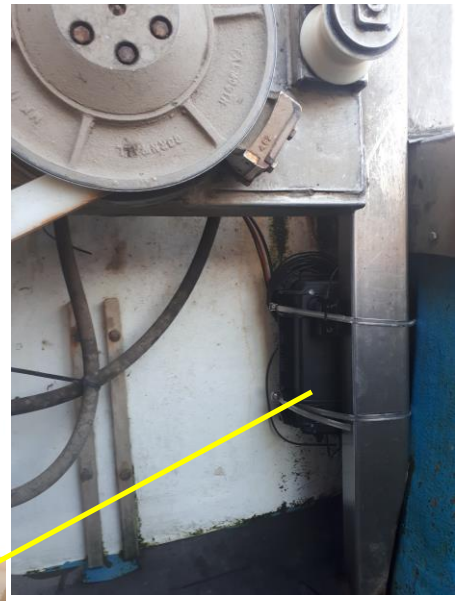
Seascope In the field- OBDCS





SIFIDS
Scottish Inshore Fisheries Integrated Data System

Seascope In the field –gear sensors linked to OBCDCS



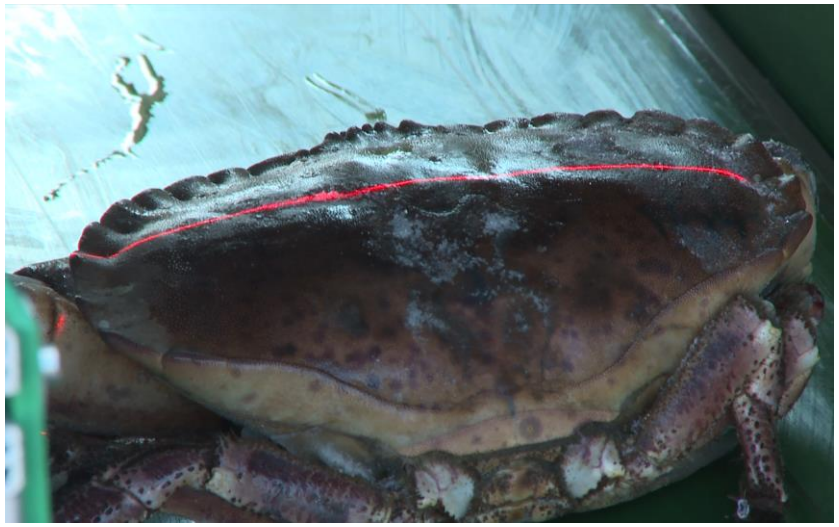
Hauler sensor

Induction sensor

RFID tag reader

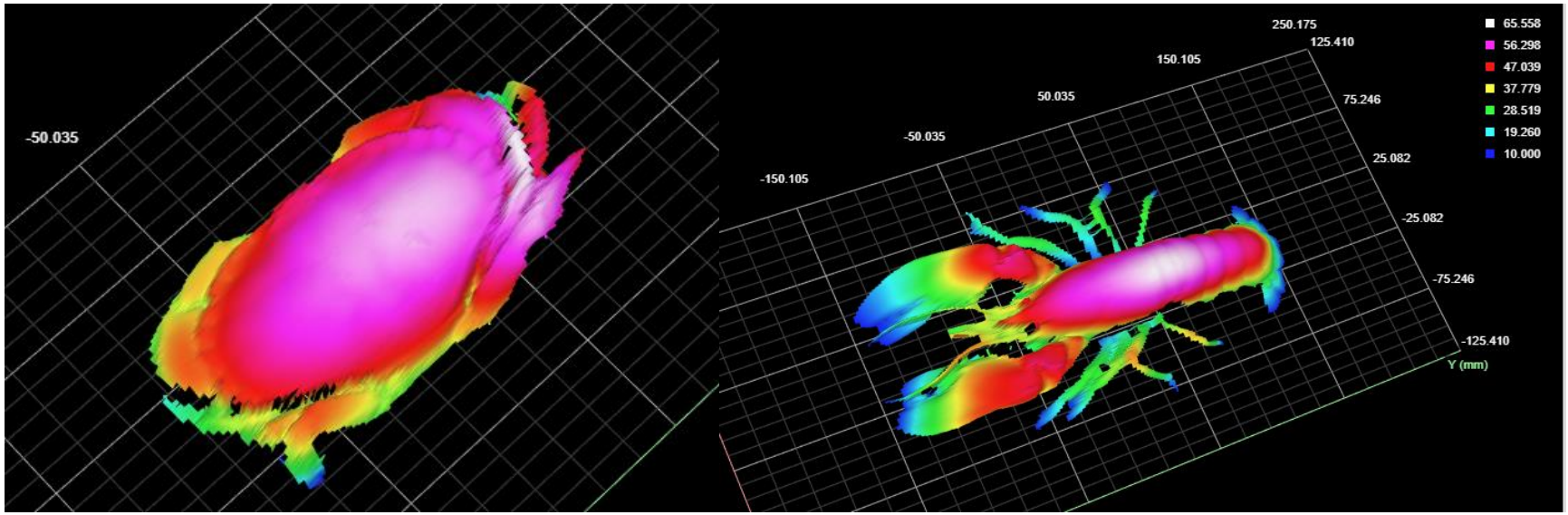
SIFIDS
Scottish Inshore Fisheries Integrated Data System

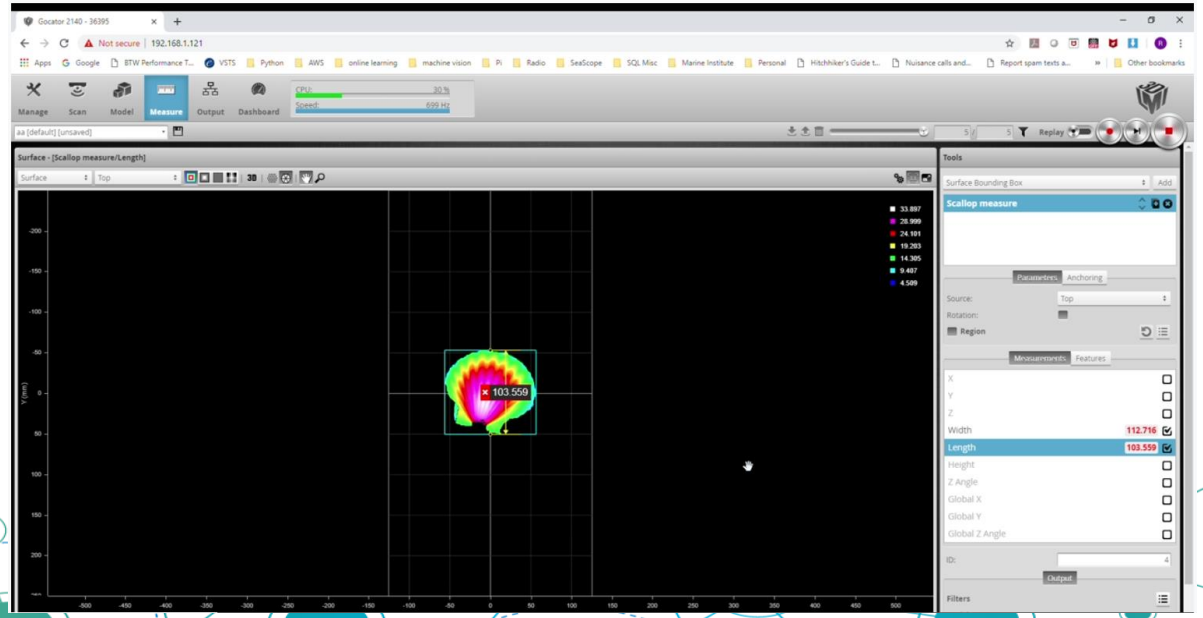
Seascope In the field- catch scanner –Species, Sex and Size Automated Identification (AsSSID)



SIFIDS
Scottish Inshore Fisheries Integrated Data System

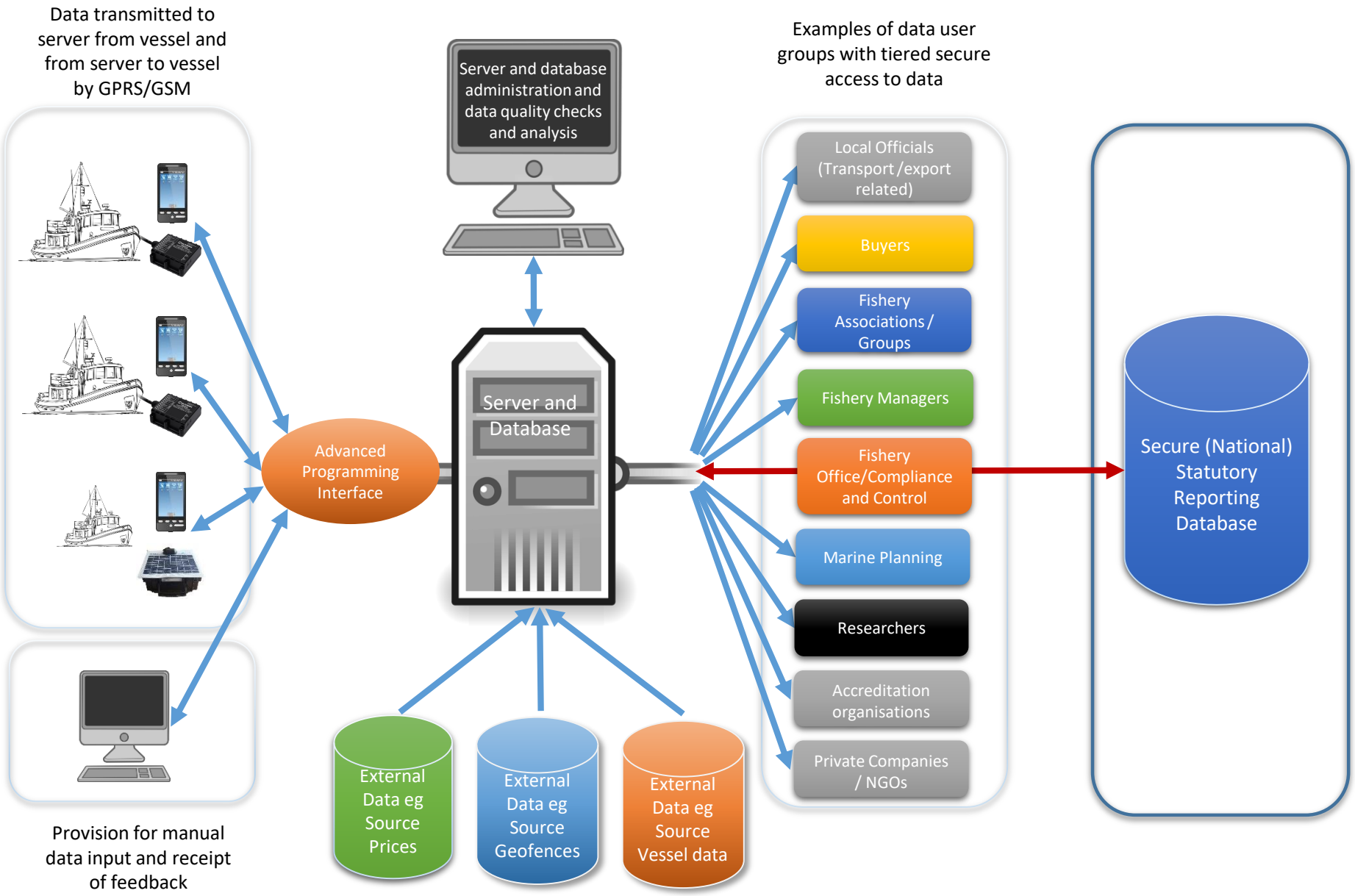
Seascope In the field-catch scanner



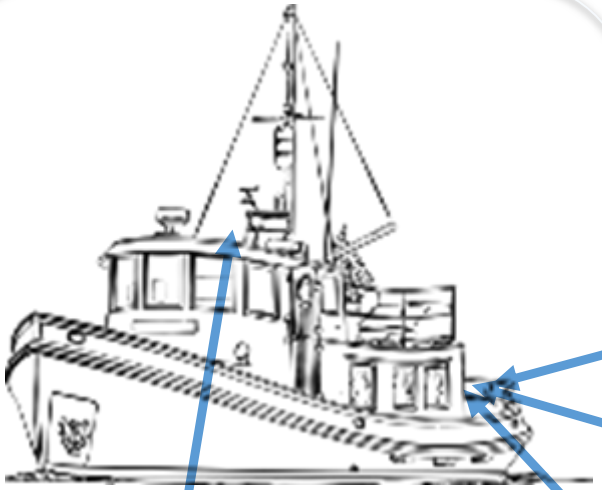


SIFIDS
Scottish Inshore Fisheries Integrated Data System

How the **basic system** could work in an operational context (All vessels under 12m)



REFERENCE FLEET system KIT



Induction sensor – pot counts

RFID sensor – string ID and counts

NAS – Data storage

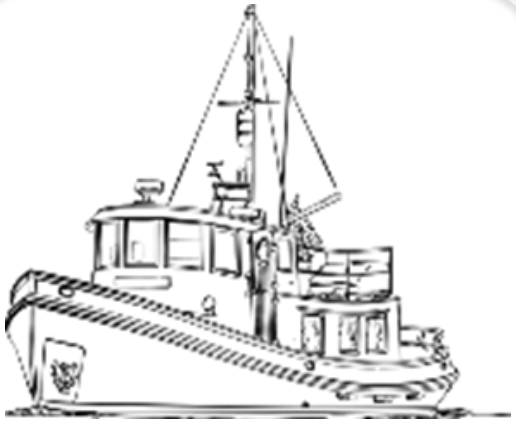
GPRS data transfer

GNSS/GPRS Tracker

Automated Species, Size and Sex Identification

SIFIDS
Scottish Inshore Fisheries Integrated Data System

How the **REFERENCE FLEET** system could work in an operational context for stock assessments



Server and database administration and data quality checks and analysis

Examples of data user groups with tiered secure access to data

Fishery Managers

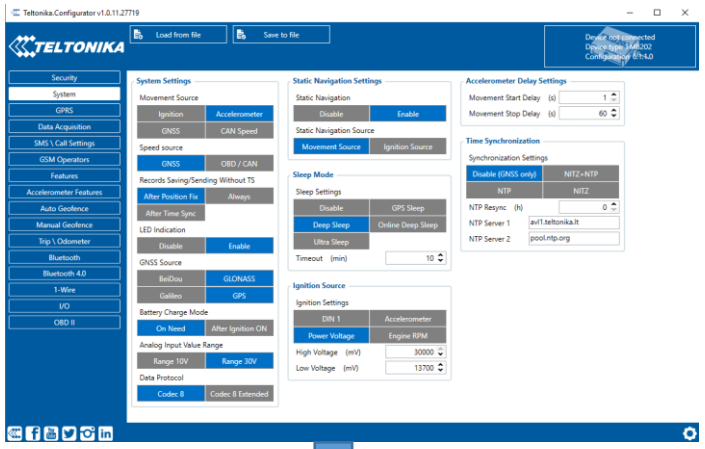
Researchers/Stock Assessment Scientists

Accreditation organisations

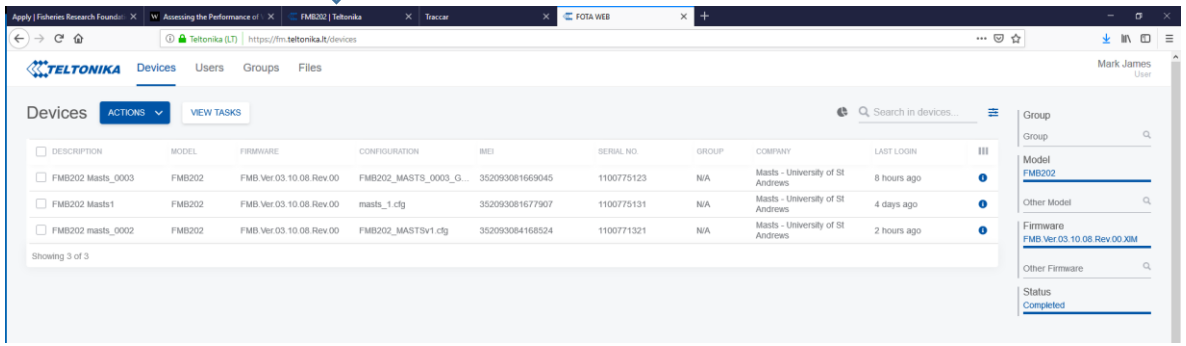
Secure (National) Statutory Reporting Database

GNSS trackers fitted onboard (vessel powered and solar) can be updated remotely

1. Configuration (remote) of the trackers can be done by management software for one, specifically selected vessels or entire fleet

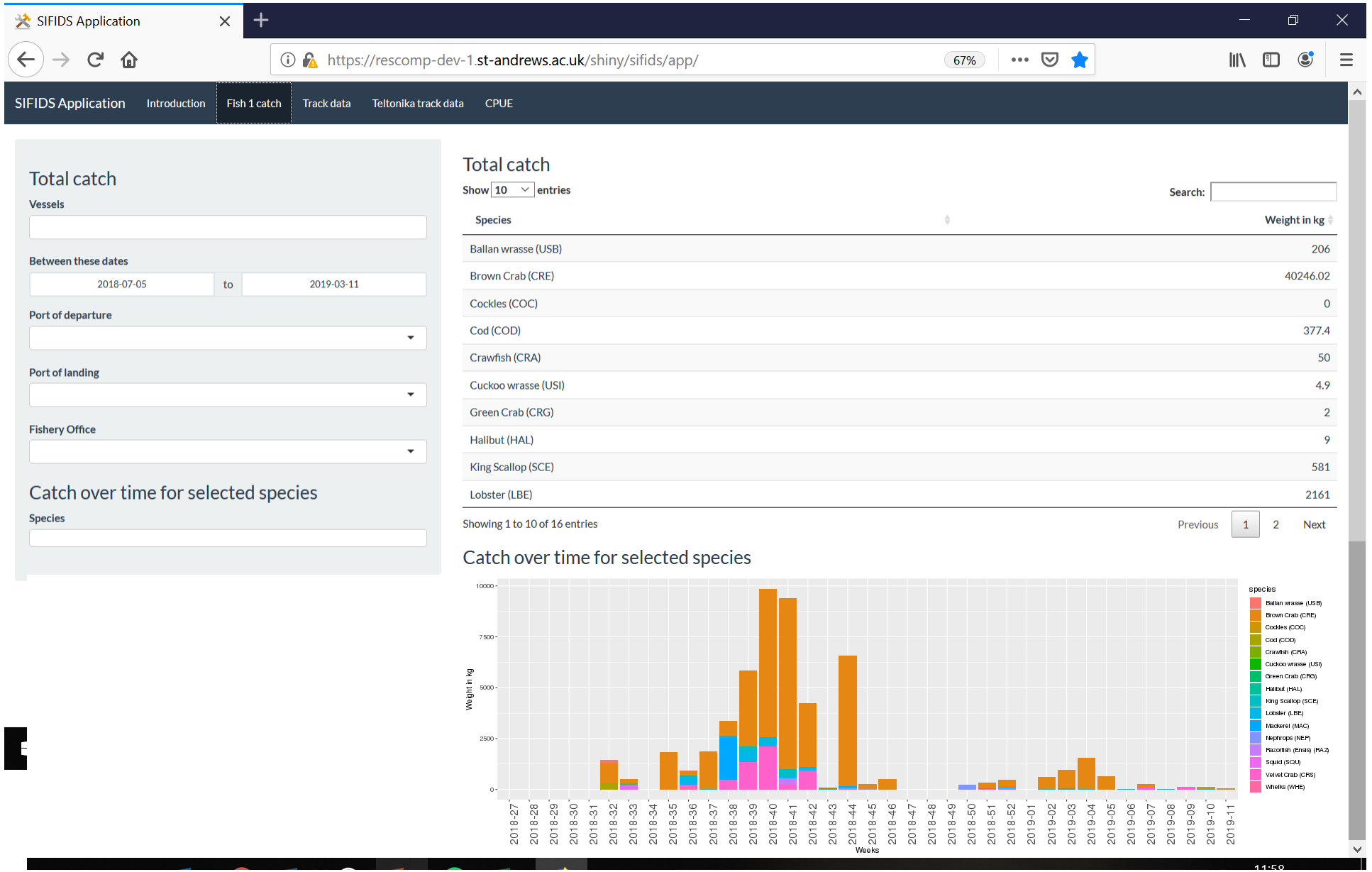


2. Upload the new tracker configuration files to be sent out



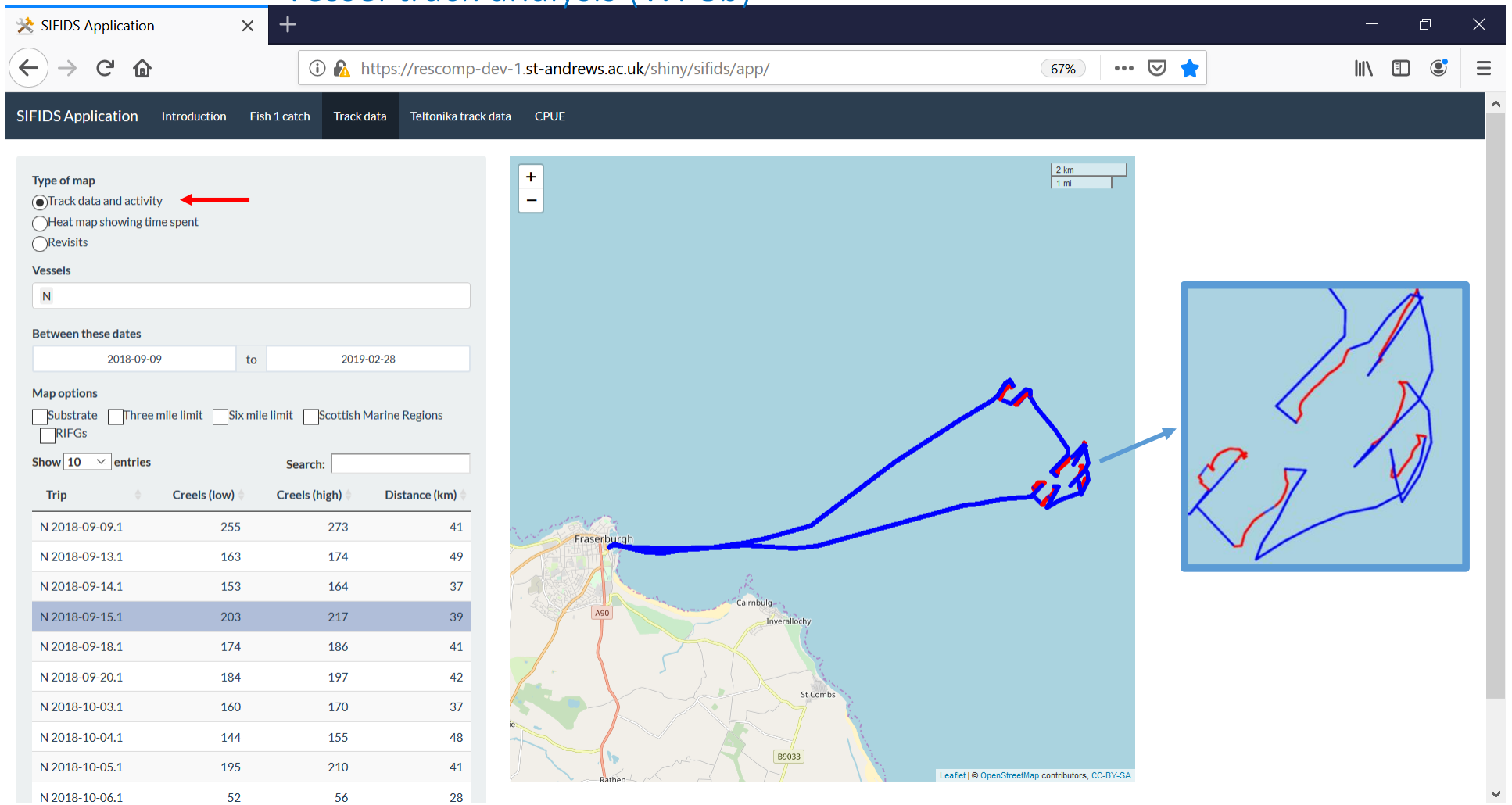
3. Send update to chosen tracker(s)

SIFIDS
Scottish Inshore Fisheries Integrated Data System



Catch information from **all** App users. information on the right is a table with totals for each species declared in theFISH1 forms and the graph showing the weight of species in each the week at least one FISH1 was submitted in

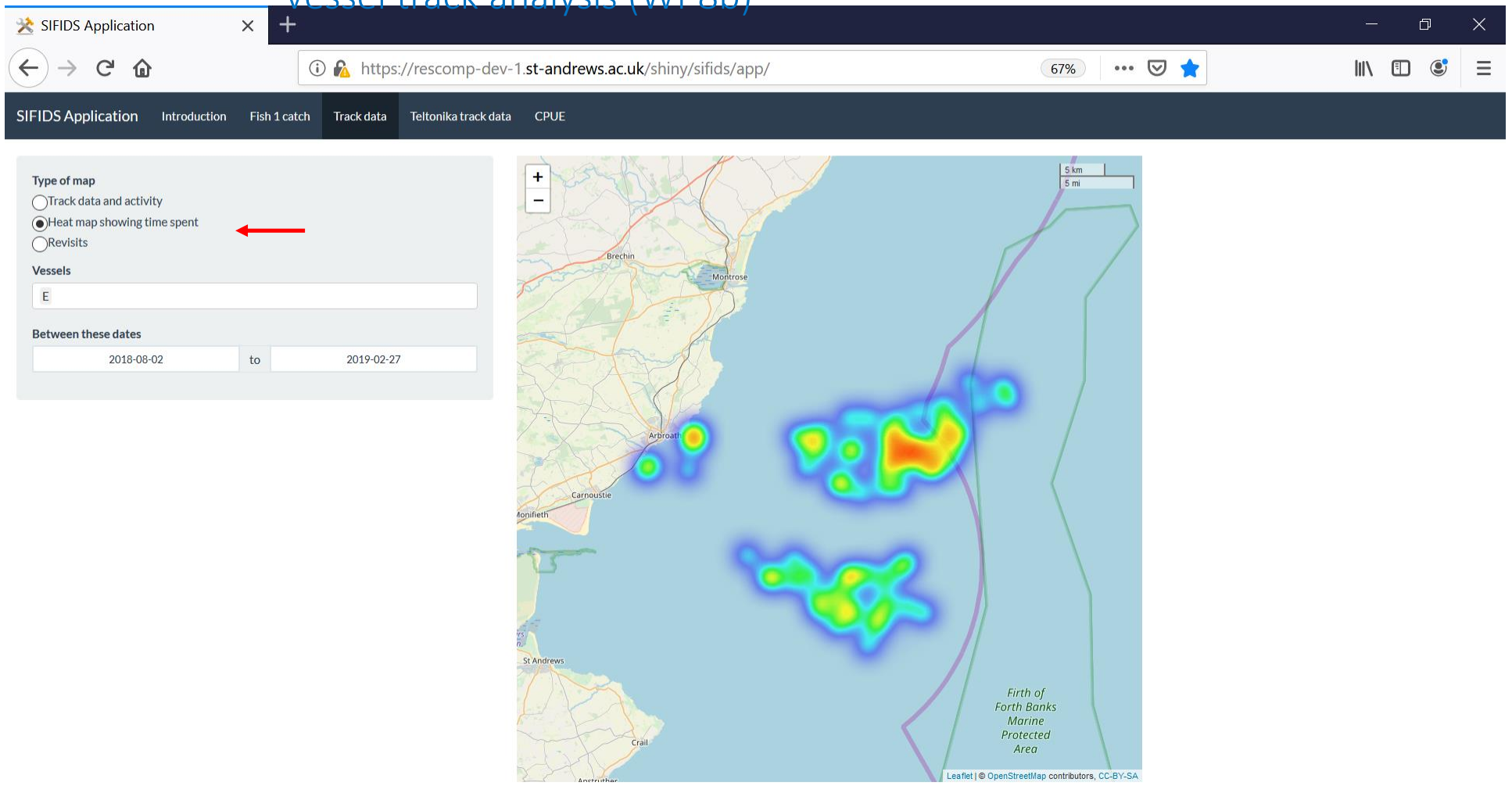
Vessel track analysis (WP8b)



How we can use GNSS track data to determine fishing activity? This tab (Track data) here shows Tania's model applied to just a GNSS track from the seascope OBCDCS, the red indicates when the model predicts fishing is occurring on 14th Sept 2018 for vessel N.

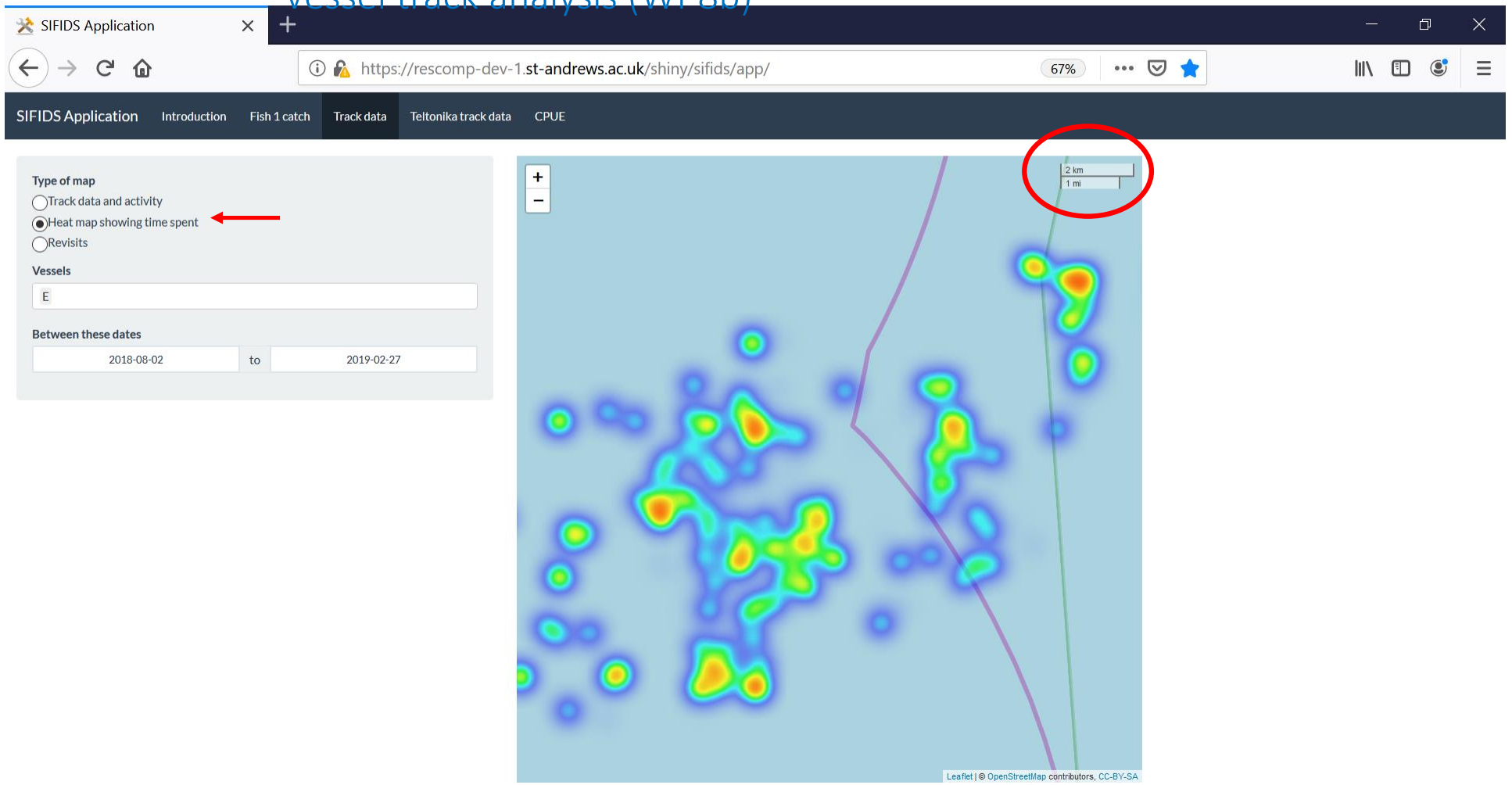
SIFIDS
Scottish Inshore Fisheries Integrated Data System

Vessel track analysis (WP8b)



How we can use GNSS track data to determine fishing hotspots? This tab (Track data) also shows Tania's model applied to just a GNSS track over a time period (2/8/2018 – 27/2/2019) but as a heat map for vessel E. The red indicate locations where the model states fishing happens at the highest frequency (highest time spent fishing), with blue being locations of lower fishing activities intensity.

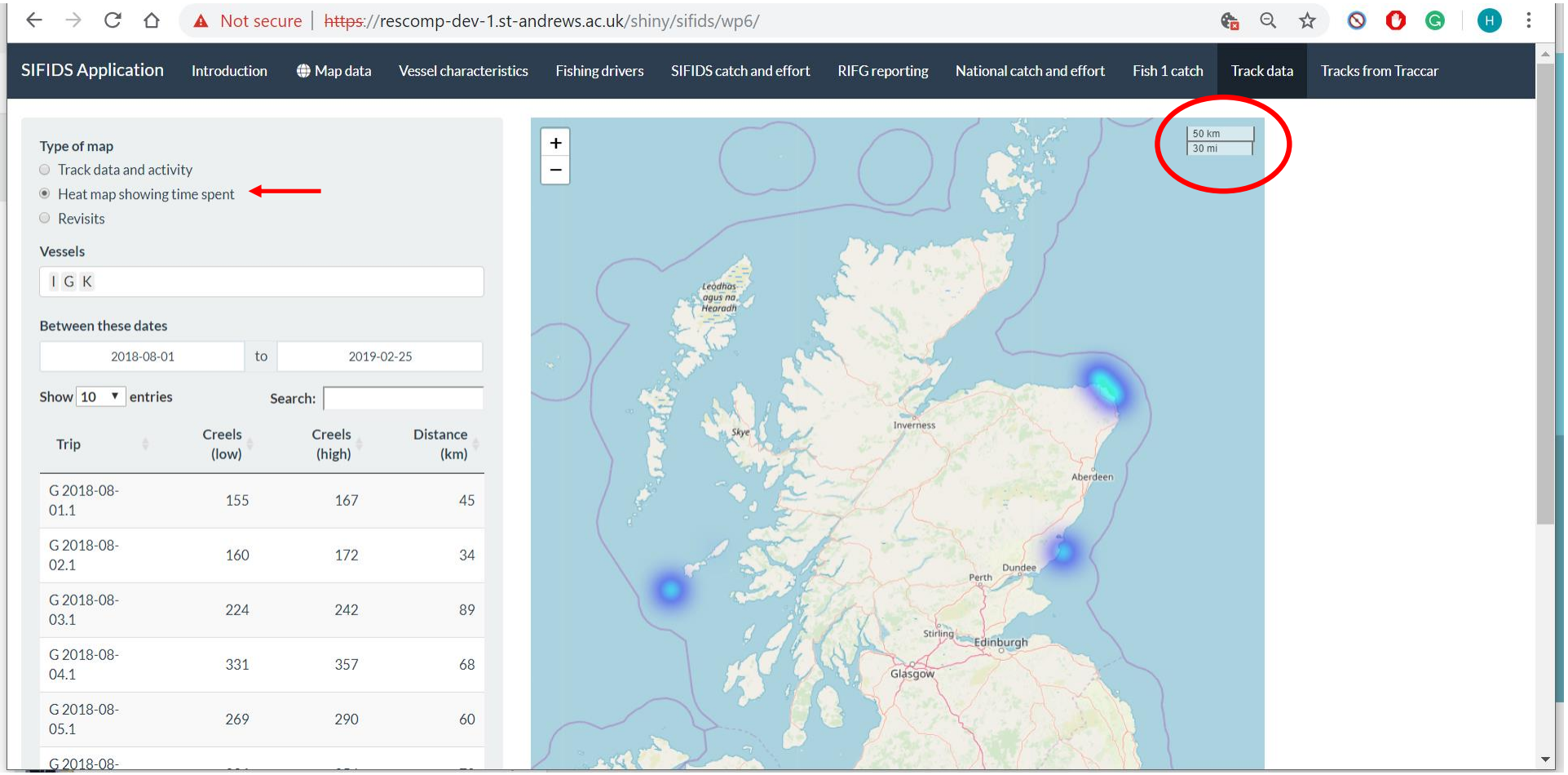
Vessel track analysis (WP8b)



This is the same map but zoomed in on one location as shown by the scale bar at the top right. Zooming improves the resolution of the heat map at a specific point.

SIFIDS
Scottish Inshore Fisheries Integrated Data System

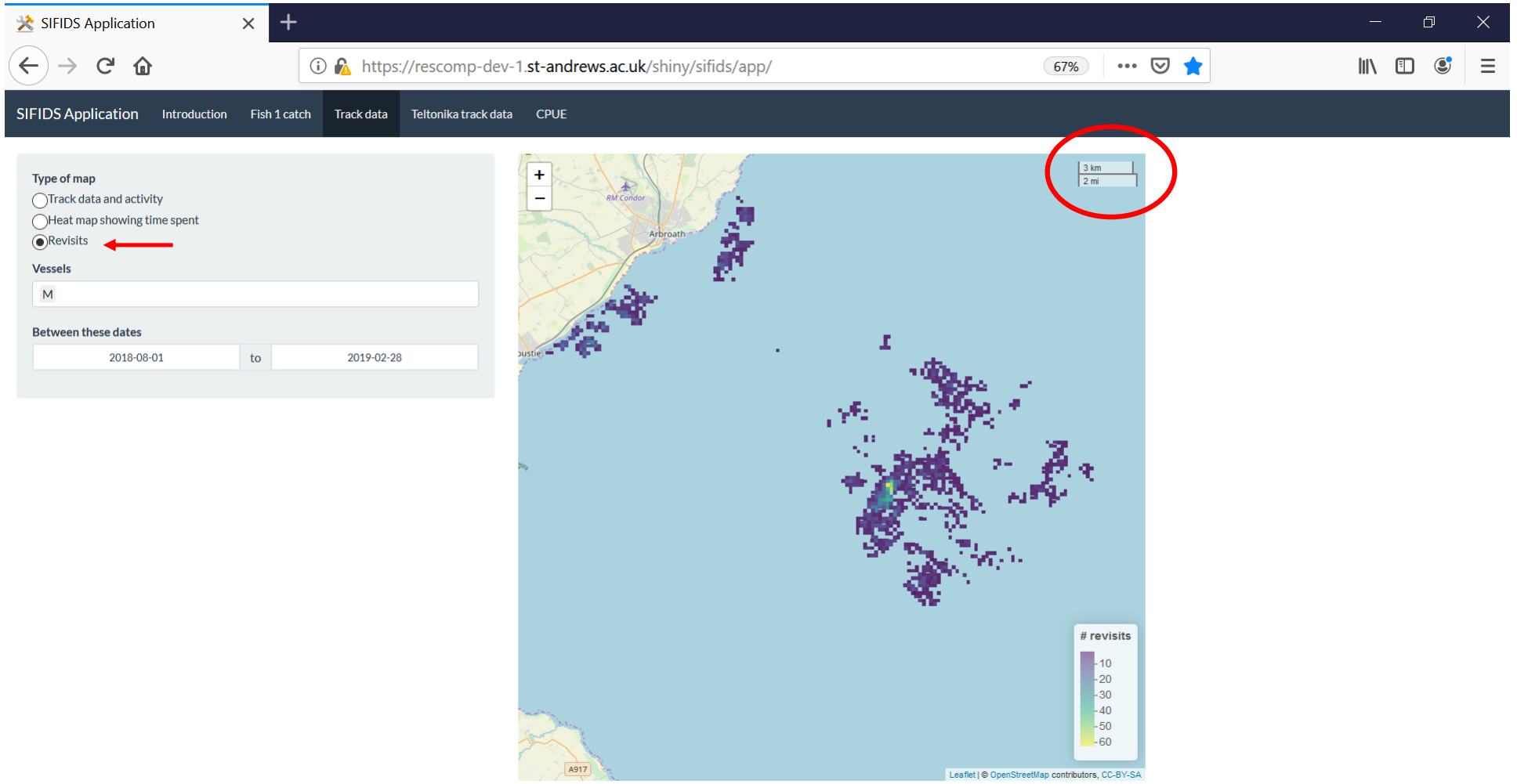
Vessel track analysis (WP8b)



This is the same map but with three vessel selected.

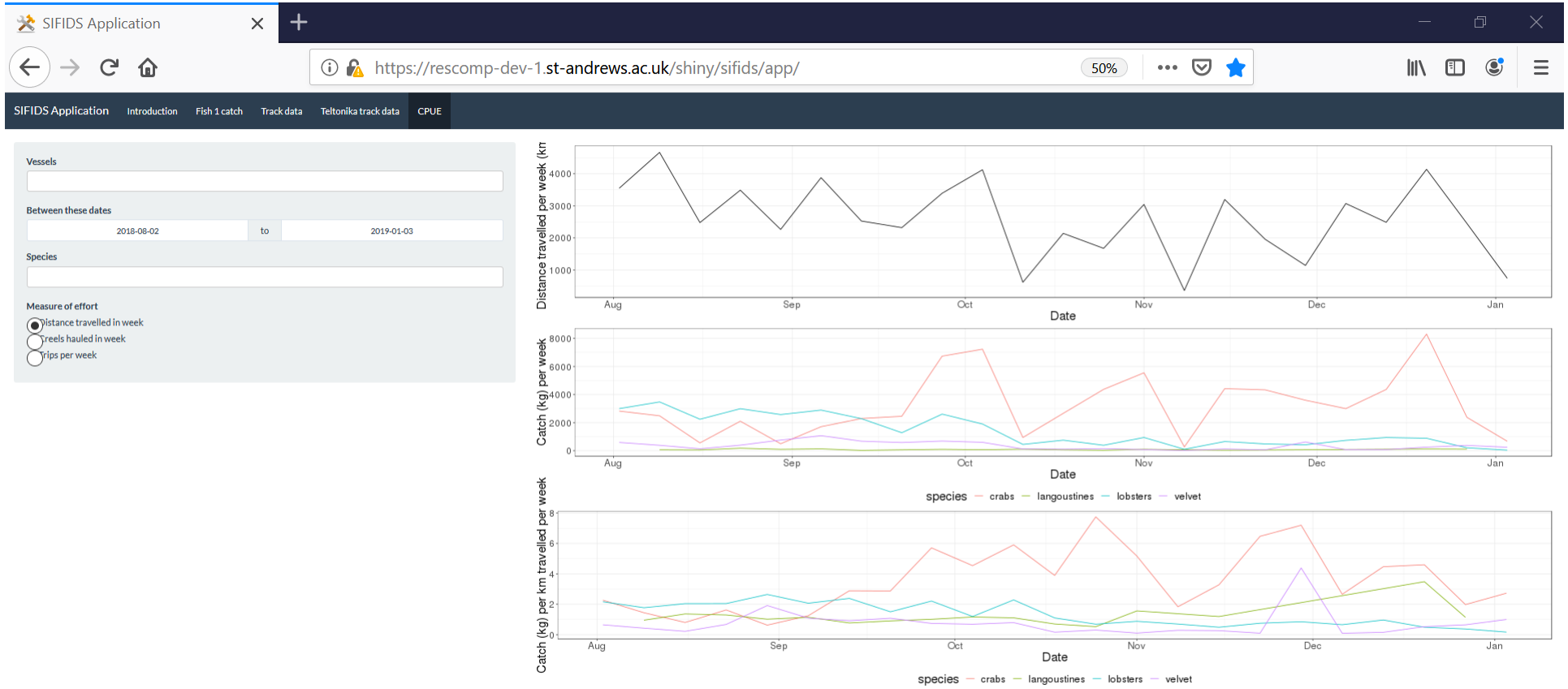
SIFIDS
Scottish Inshore Fisheries Integrated Data System

Vessel track analysis (WP8b)



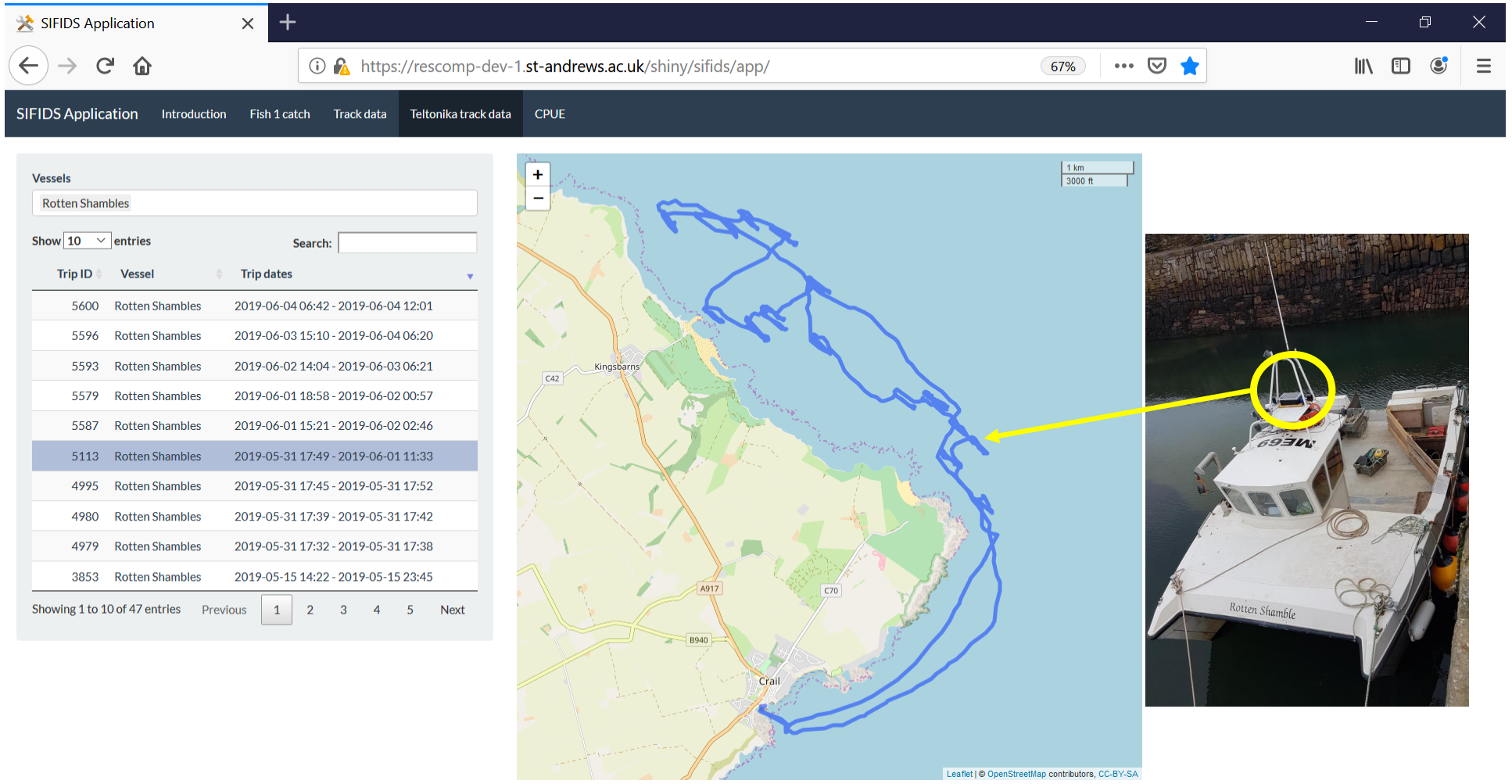
SIFIDS
Scottish Inshore Fisheries Integrated Data System

Catch Per Unit Effort visualisation



We combined the tracks from Seascope's OBCDCS system with FISH1 forms to calculate CPUE for the entire fleet here, three options to measure effort can be selected: distance travelled in week, Creel hauled in week and trips per week. All species listed in the FISH1 forms allowed species specific visualisation.

DISPLAYING SOLAR TRACKER DATA (TELTONIKA DEVICE)



The Teltonika track data tab shows the tracks of the solar Teltonika tracker fitted on vessel Rotten Shambles (pictured)

FISHER'S DRIVERS

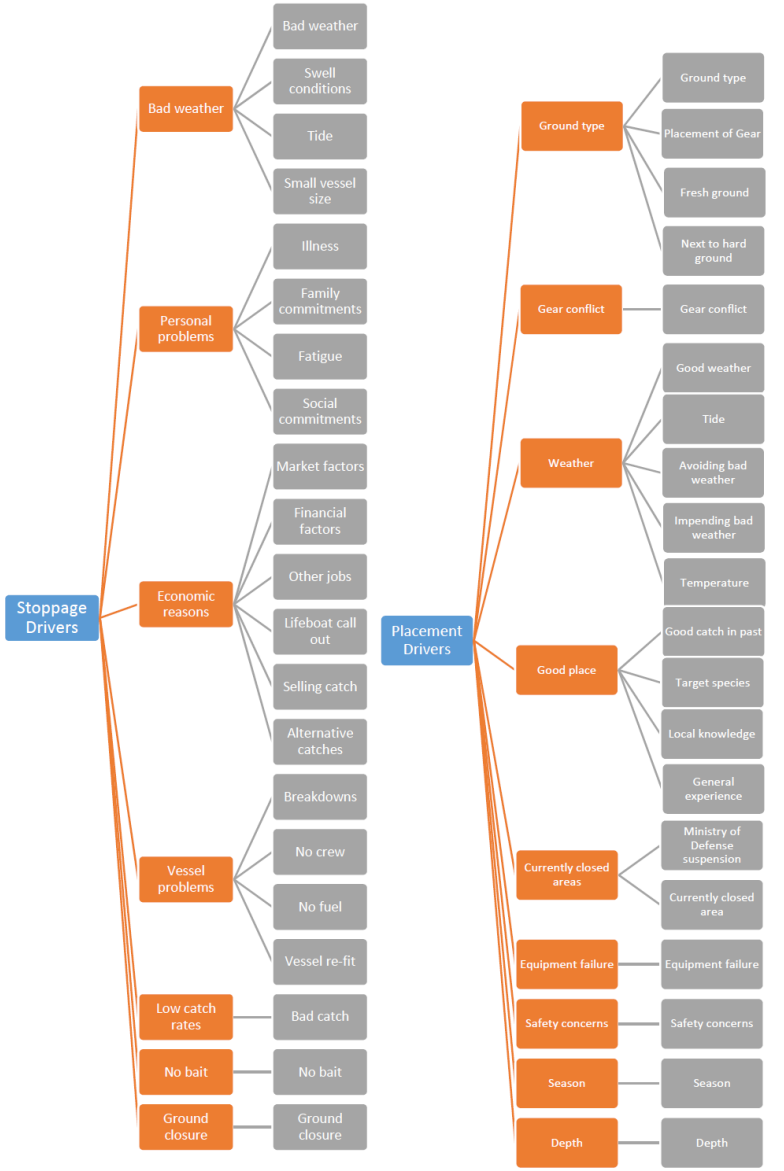


Fig. 10 Regrouped stoppage drivers (left) and placement drivers (right). Grey indicates the drivers supplied by fishermen. Orange indicates the new regrouped drivers.

Fig. 12 Reported wind directions associated with decisions to avoid fishing on a given day, by area and port. West coast - blue, Outer Hebrides – light blue, east coast – red, and northern east coast- orange

FISHER'S DRIVERS

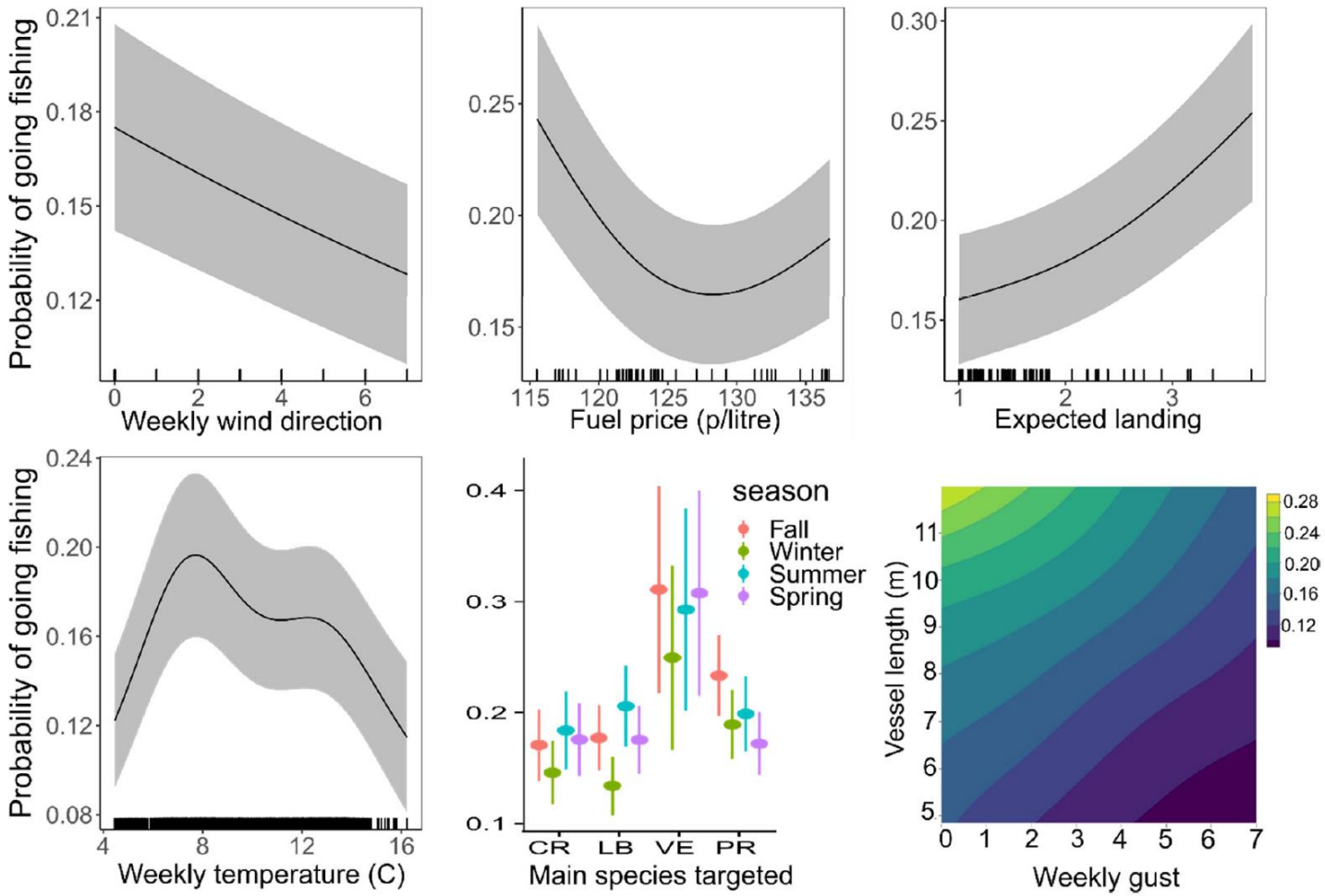
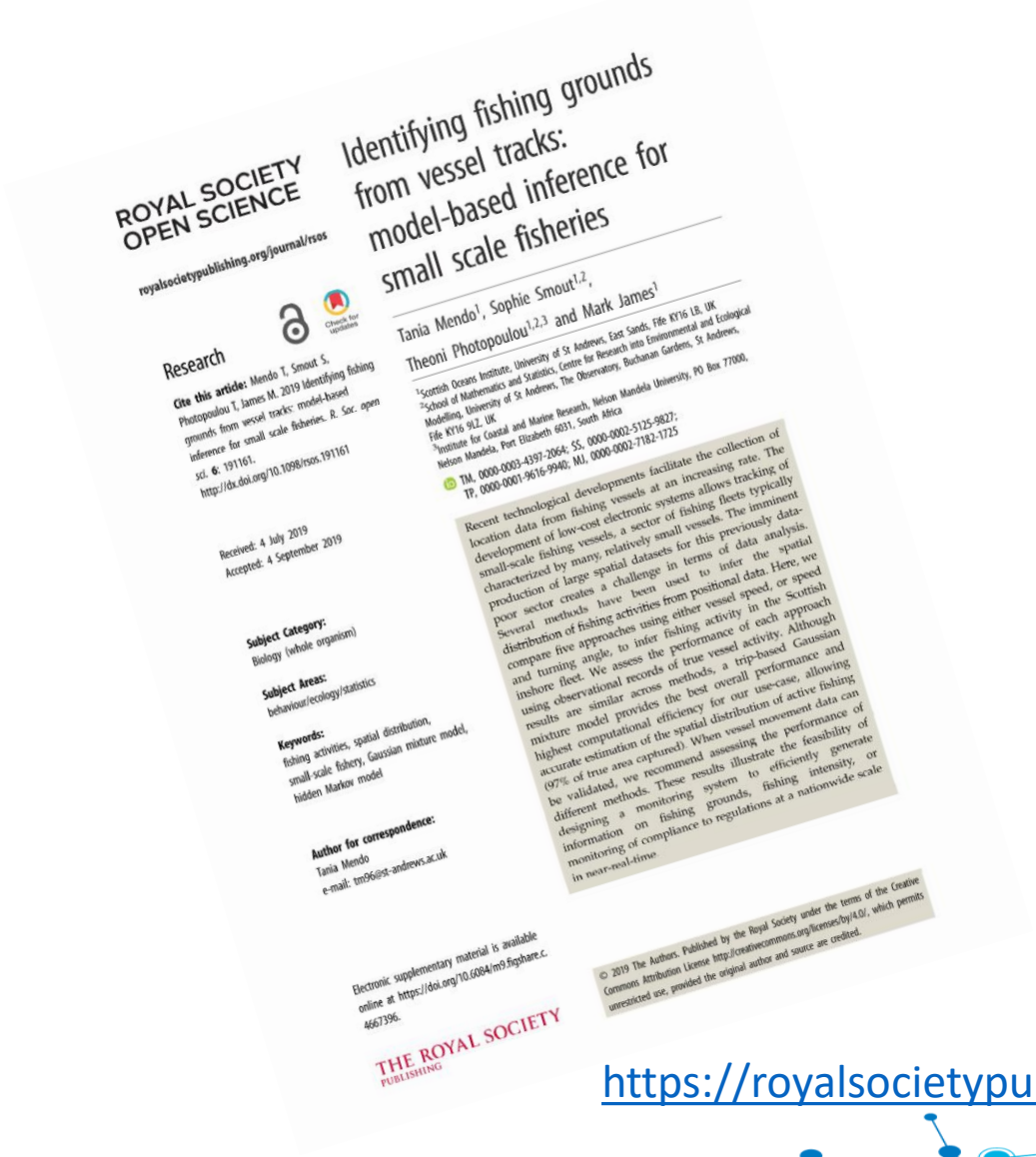


Fig. 21 Relationship between the predicted probability of going fishing (proportion of days per fishing week) and each explanatory variable in final model.

- Using understanding of fisher behaviour to inform decision making and investment
- Using Behavioural Insights to change fisher behaviour

- USTAN+BIT+Telecoms Company = Marine Science + Behavioural Psychologist + Analytics and global reach (600m customers)



ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Research

Cite this article: Mendo T, Smout S, Photopoulou T, James M. 2019 Identifying fishing grounds from vessel tracks: model-based inference for small scale fisheries. *R. Soc. open sci.* **6**: 191161. http://dx.doi.org/10.1098/rsos.191161

Received: 4 July 2019
Accepted: 4 September 2019

Subject Category:
Biology (whole organism)

Subject Areas:
behaviour/ecology/statistics

Keywords:
fishing activities, spatial distribution, small-scale fishery, Gaussian mixture model, hidden Markov model

Author for correspondence:
Tania Mendo
e-mail: tm96@st-andrews.ac.uk

Electronic supplementary material is available online at https://doi.org/10.6084/m9.figshare.c.4667396.

THE ROYAL SOCIETY PUBLISHING

Identifying fishing grounds from vessel tracks: model-based inference for small scale fisheries

Tania Mendo[1], Sophie Smout[1,2], Theoni Photopoulou[1,2,3] and Mark James[1]

[1]Scottish Oceans Institute, University of St Andrews, East Sands, Fife KY16 LB, UK
[2]School of Mathematics and Statistics, Centre for Research into Environmental and Ecological Modelling, University of St Andrews, The Observatory, Buchanan Gardens, St Andrews, Fife KY16 9LZ, UK
[3]Institute for Coastal and Marine Research, Nelson Mandela University, PO Box 77000, Nelson Mandela, Port Elizabeth 6031, South Africa

TM, 0000-0003-4397-2064; SS, 0000-0002-5125-9827; TP, 0000-0001-9616-9940; MJ, 0000-0002-7182-1725

Recent technological developments facilitate the collection of location data from fishing vessels at an increasing rate. The development of low-cost electronic systems allows tracking of small-scale fishing vessels, a sector of fishing fleets typically characterized by many, relatively small vessels. The imminent production of large spatial datasets for this previously data-poor sector creates a challenge in terms of data analysis. Several methods have been used to infer the spatial distribution of fishing activities from positional data. Here, we compare five approaches using either vessel speed, or speed and turning angle, to infer fishing activity in the Scottish inshore fleet. We assess the performance of each approach using observational records of true vessel activity. Although results are similar across methods, a trip-based Gaussian mixture model provides the best overall performance and highest computational efficiency for our use-case, allowing accurate estimation of the spatial distribution of active fishing (97% of true area captured). When vessel movement data can be validated, we recommend assessing the performance of different methods. These results illustrate the feasibility of designing a monitoring system to efficiently generate information on fishing grounds, fishing intensity, or monitoring of compliance to regulations at a nationwide scale in near-real-time.

Questions?

https://royalsocietypublishing.org/doi/full/10.1098/rsos.191161

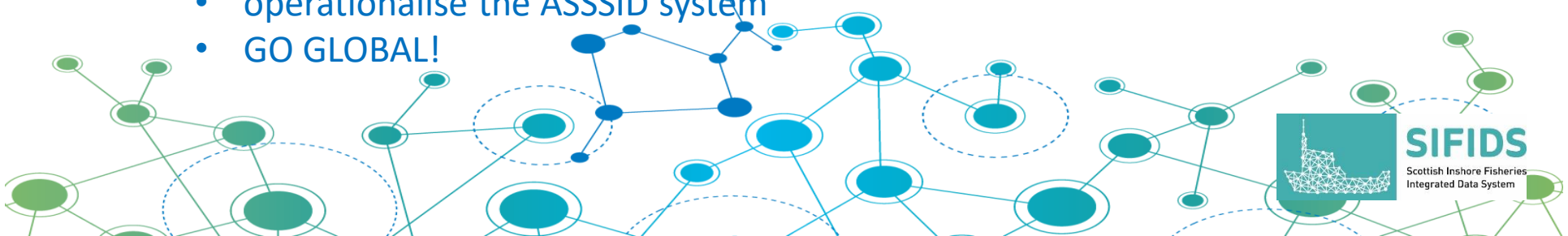
Marine Alliance Science Technology Scotland
University of St Andrews
The Scottish Government Riaghaltas na h-Alba
marinescotland
CRMG
Coastal Resources Management Group
European Maritime & Fisheries Fund

What NEXT?

- Modernisation of the Inshore Fishery – Programme for Government 2020
- For vessel registered commercial fishing vessels in Scotland:
- Fit all Scottish managed scallop dredge vessels with REM systems starting 2019 (100)
- Fit all under all12m trawl and static gear vessels (118 trawl and 1440 static) with “appropriate and proportionate” data collection and monitoring equipment – by end of 2020
- Establish the necessary infrastructure – engineering services and IT.

For SIFIDS – [the above???]

- continue to develop models to predict fishing activity of all gear types
- explore additional environmental sensor capability and possible H&S functions
- upgrade the App to make more user friendly and adaptable
- operationalise the ASSSID system
- GO GLOBAL!



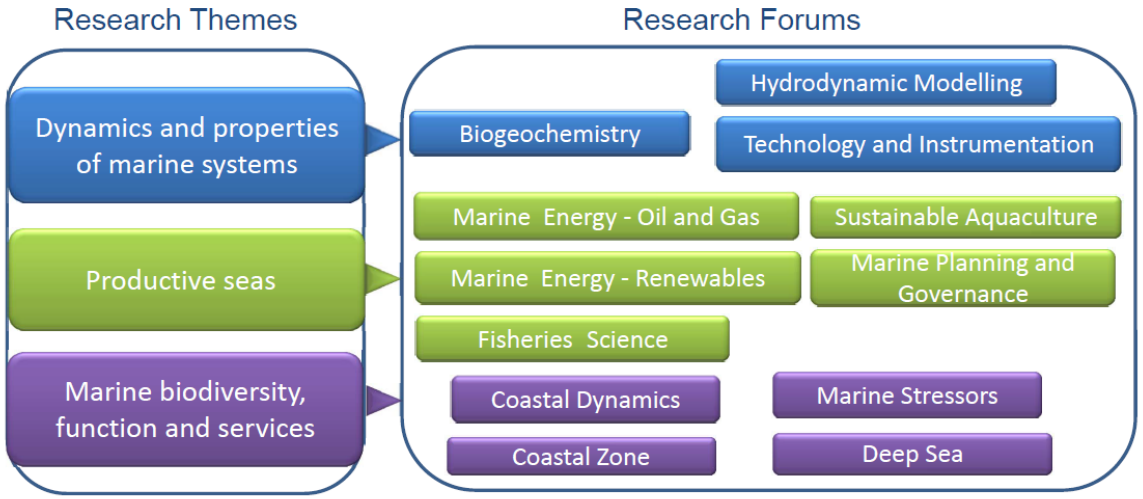
Marine Alliance for Science and Technology for Scotland - Overview

http://www.masts.ac.uk

MASTS – brings together Scotland's marine science capacity within a single organisation

- Ensures Scottish marine science remains **internationally competitive**
- Provides the **academic platform** and **knowledge for marine governance and commerce**

MASTS engages ~700 researchers across 17 Universities, Research Institutes, Government and Non-Departmental Public Bodies



European MARINE BOARD Advancing Seas & Oceans Science

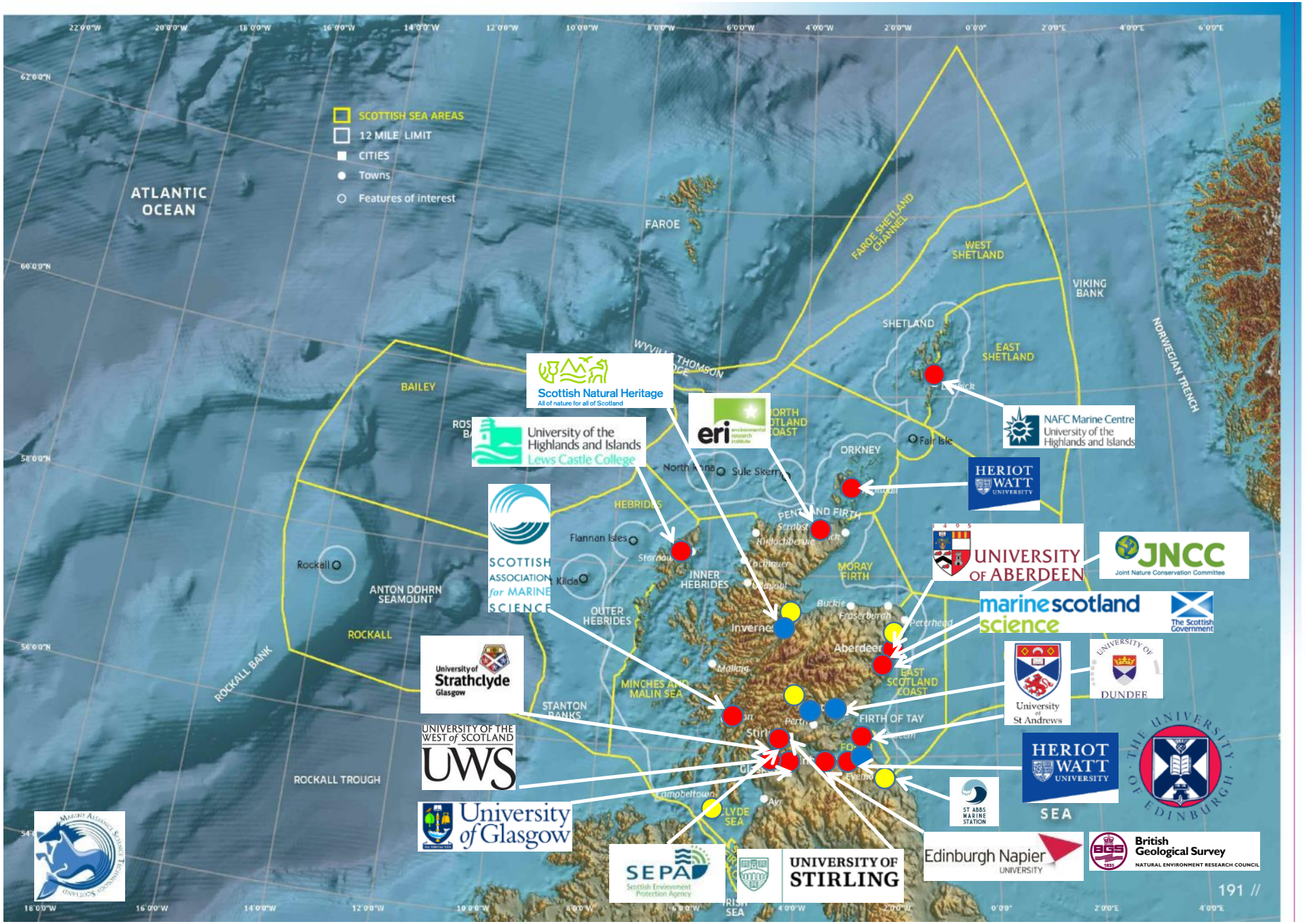
UK - Marine Science Co-ordination Committee (MSCC)

EMBRC EUROPEAN MARINE BIOLOGICAL RESOURCE CENTRE

marinescotland

Marine Strategy Forum

The Scottish Government Riaghaltas na h-Alba

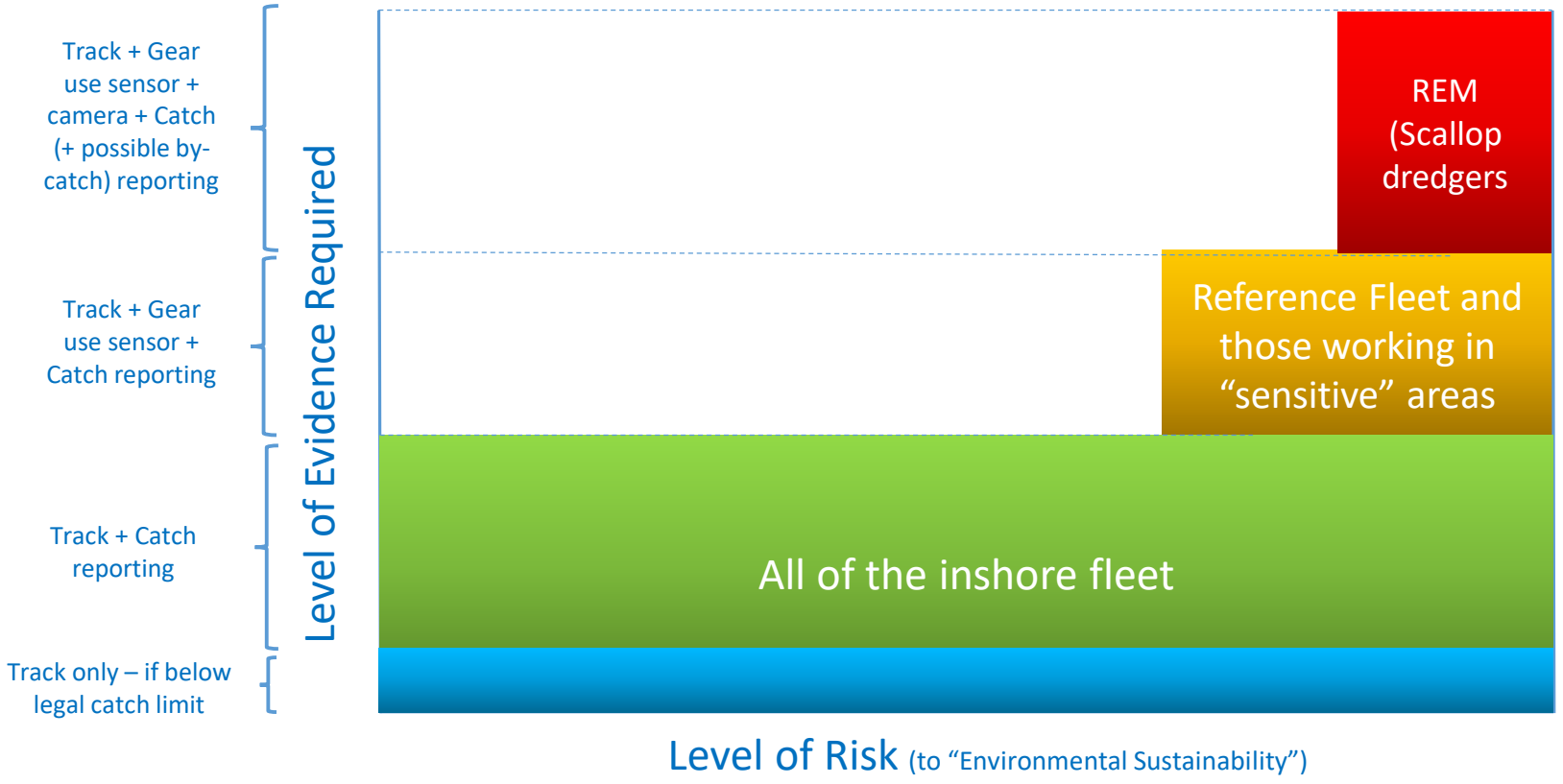

SCOTTISH SEA AREAS
12 MILE LIMIT
CITIES
Towns
Features of interest
ATLANTIC OCEAN
FAROE
FAROE SHETLAND CHANNEL
WEST SHETLAND
VIKING BANK
NORWEGIAN TRENCH
SHETLAND
EAST SHETLAND
ORKNEY
Fair Isle
BAILEY
ANTON DOHRN SEAMOUNT
ROCKALL
ROCKALL BANK
ROCKALL TROUGH
Rockall
HEBRIDES
Flannan Isles
Stornoway
Kilda
INNER HEBRIDES
OUTER HEBRIDES
MORAY FIRTH
PENTLAND FIRTH
Inverness
Aberdeen
Buckie
Fraserburgh
Peterhead
EAST SCOTLAND COAST
FIRTH OF TAY
Perth
Stirling
Oban
Campbeltown
Ayr
MINCHES AND MALIN SEA
STANTON BANKS
LYDE SEA
IRISH SEA
Scottish Natural Heritage
All of nature for all of Scotland
eri
University of the Highlands and Islands
Lews Castle College
NAFC Marine Centre
University of the Highlands and Islands
HERIOT WATT UNIVERSITY
SCOTTISH ASSOCIATION for MARINE SCIENCE
UNIVERSITY OF ABERDEEN
JNCC
Joint Nature Conservation Committee
marine scotland science
The Scottish Government
University of Strathclyde Glasgow
University of St Andrews
UNIVERSITY OF DUNDEE
UNIVERSITY OF THE WEST of SCOTLAND
UWS
HERIOT WATT UNIVERSITY
SEA
THE UNIVERSITY OF EDINBURGH
ST ABBS MARINE STATION
University of Glasgow
SEPA
Scottish Environment Protection Agency
UNIVERSITY OF STIRLING
Edinburgh Napier UNIVERSITY
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
191 //

WHAT CAN SCIENCE DO?

- Speak truth to power
- Challenge convention
- Get off the fence
- Challenge drives innovation, new ways of thinking and doing!
- Embrace and harness all areas of knowledge development, data acquisition
- Low cost – open source – open access – community driven and owned
- Can’t manage the environment – can try to manage people
- Behavioural insights – behavioural change
- Mobile technologies – big data – analytics underpinned by objective science – not populist

Risk based data collection assessment

Risk Category	Consequence (A) Mild – 1 Severe – 5	Likelihood (B) Low – 1 High – 5	Details	Risk Consequences	Joint Risk (A*B)	Level of Evidence GNSS – Spatio-temporal data GS – Gear sensor(s) C-IP Video camera E – Effort measure
Gear Type (All Gear types could be subdivided to cover variations in type or operation						
Dredging	5	4	Mobile gear in contact with or in close proximity to the seabed	Damage to the seabed and/or associated fauna/flora/high levels of by-catch	20	GNSS + GS + C
Electric fishing	5	4	Mobile gear in contact with or in close proximity to the seabed. Insufficient information to assess potential environmental impacts.	Possible damage to the seabed and/or associated fauna/flora/high levels of by-catch	20	GNSS + GS + C
Benthic trawling	4	4	Mobile gear in contact with or in close proximity to the seabed	Damage to the seabed and/or associated fauna/flora/ high levels of by-catch	16	GNSS + GS
Pelagic trawling	4	3	Mobile gear not in contact with the seabed	Bycatch of mobile PETS	12	GNSS + GS
Static nets	4	2	Static gear suspended in water column	Possible localised damage to seabed and bycatch of mobile PETS	8	GNSS
Pots/traps in strings	2	3	Static gear strung together and in contact with the sea bed	Possible localised damage to seabed and entanglement with mobile PETS	6	GNSS
Pots/traps singles	2	2	Static gear deployed individually in contact with the seabed	Possible entanglement with mobile PETS	4	GNSS
Long line	3	3	Static gear with multiple hooks on suspended line	Possible by catch and entanglement of mobile PETS	9	GNSS
Commercial Rod and line	2	1	Single or multiple hooks suspended from a fishing rod – static or trawled	Possible by catch of PETS	2	GNSS
Diver hand caught	2	2	Diver collecting shellfish by hand from the seabed	Possible localised overfishing	4	GNSS + E
Location / Time (Where fishing is taking place and time – if relevant to restriction)						
Entering a restricted area	4	3	Accidental or deliberate infringement of an area where fishing is prohibited	Possible damage to habitats, PETS, infrastructure + potential for fishers to be implicated in illegal activity	12	GNSS + GS
Fishing in a restricted area	5	2	Accidental or deliberate fishing in a prohibited area	Possible damage to habitats, PETS, infrastructure + potential for fishers to be implicated in illegal activity	10	GNSS + GS
Other considerations						
Gear conflict	5	2	Mobile and static gear fisheries prosecuting the same area at the same time	Accidental or deliberate loss of static fishing gear. Denial of legitimate mobile fishing opportunities.	10	GNSS + GS
Previous history of non-compliance in sector/fleet	4	5	Any breaches in compliance with respect to Gear Type, Location or Time restriction or Catch/By-catch/Discarding	Lower risk categories for gear type, use, location, time or nature of catch or discarding becomes higher risk because a significant proportion of the fleet is non-compliant	20	GNSS + GS + C



Level of risk assessed and thresholds for level of evidence required, determined through formal risk assessment using expert elicitation process

Number of vessels in each evidence requirement category is proportional to the coloured area on the graph.

SIFIDS
Scottish Inshore Fisheries Integrated Data System