



D3.3 Location and management system

Pre-production prototype surface locator units (SLU) with location app and online tag management tools (TRL 8). SLU further developed to incorporate directivity in the vertical plane and hence increase the communication radius/reduce search time; and also improve immunity to local surface and vessel generated acoustic noise. Mechanisms for rapid and flexible deployment of the SLU on a variety of vessels, along with a user-friendly Android/iOS locator app with seamless interface to the SLU via Bluetooth Low Energy (BLE) wireless technology.



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Summary NETTAG+ Project

NETTAG+ aims to provide a portfolio of three innovative smart and sustainable solutions to address the negative impacts of abandoned, lost or otherwise discarded fishing gear (ALDFG) on marine life and habitats. NETTAG+ will be based on synergistic activities between the fisheries industry, scientists and NGOs to develop three solutions to PREVENT, AVOID and MITIGATE the harmful impacts of ALDFG.

NETTAG+ will PREVENT marine litter derived from fisheries activities, AVOID loss of fishing gears, and MITIGATE harmful impact by removing existing ALDFG. These three solutions will jointly contribute to reduce ALDFG and marine pollution, namely by: reducing the introduction of hazardous chemicals and microplastics originating from ALDFG; reducing ghost fishing, bycatch and entanglements of sensitive or endangered species on ALDFG; and improving mapping, tracking and recovery technologies to retrieve ALDFG.

NETTAG+ aims to upgrade and upscale the integrative preventive approach that started in the previous NetTag project, and aims to replicate it in Mediterranean regions, providing the fisheries industry with three smart and environmentally-friendly solutions to reduce ALDFG and prevent the environmental impacts of fishing gears. The three solutions will be developed to maturity (TRL 7-8) by the end of the project, and will be tested, validated and demonstrated in real conditions in Atlantic and Mediterranean countries, namely Portugal (PT), United Kingdom (UK), Spain (SP), Italy (IT), Croatia (HR) and Malta (MT). NETTAG+'s ambition is to change the paradigm of the fisheries industry, aspiring to transform the societal perspectives about the role of fishers as Guardians and Cleaners of the Ocean. NETTAG+ will empower the sector to take effective actions to address marine pollution, promoting their role as key actors to tackle marine pollution.

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Executive Summary

This document describes the design of production hardware for the NETTAG+ surface locator unit (SLU). It also describes the design of production software for the NETTAG+ locator app, running on Android and IOS mobile devices, which guides the user through the location process using acoustic ranging and trilateration. Both elements have reached TRL 8 and together with the NETTAG+ acoustic tags they form a complete system for the rapid and easy location of lost gear equipped with the tags. A potential enhancement with a directional acoustic transducer assembly for the SLU has been investigated, but although some improvement in performance was achieved, this was insufficient to justify the increase in hardware complexity and cost.

The resulting system has now been commercialised through project partner Succorfish and is now being evaluated by initial end users worldwide.

1 Introduction

The NETTAG+ location system uses the concept that was extensively tested and proven during the original NetTag project [1], illustrated in Figure 1. In order to move the system from TRL 5/6 to TRL 8, ready for commercialisation and unsupervised use by fishers, the following tasks needed to be completed:

- Design of a robust surface locator unit with easy and flexible deployment on any vessel.
- Maximum range capability achieving a wide search area for tag location.
- Simple interfacing to a variety of mobile devices running the app.
- Intuitive and reliable location app, with clear graphical user interface.
- Easy registration and management of tags (with unique IDs).

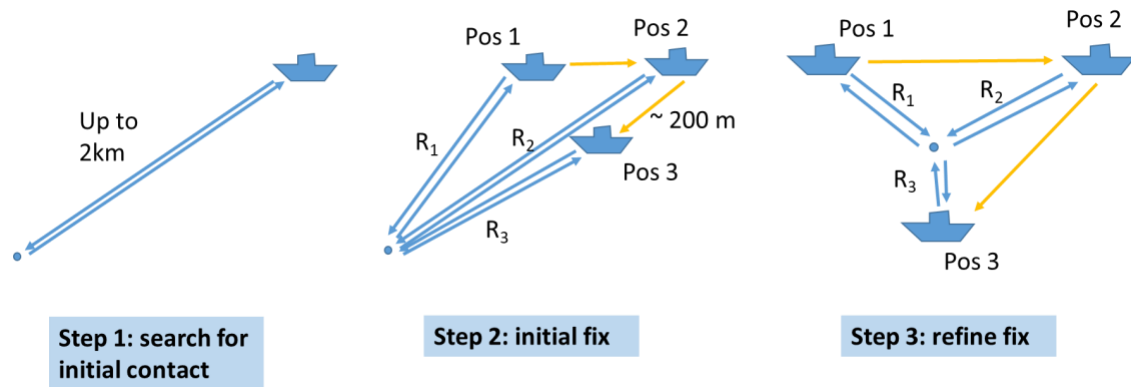


Figure 1. NetTag/NETTAG+ location concept.

As with the tag design, low component and assembly costs are critical to enable an affordable solution for widespread use by fishers, including in low resource settings.

2 Surface locator unit (SLU)

2.1 SLU hardware development

To minimise productions costs, many of the component parts of the NETTAG+ transponder/tag [2] are reused in the design of the SLU, pictured in Figure 2. The same waterproof plastic housing (manufactured from recycled fishing gear) is used to house the battery and electronics, with a modified top assembly to allow connection of a cabled transducer for lowering into the water. A stainless steel collar is attached to the transducer to give extra weight to keep it down in the presence of sea currents. The acoustic transceiver circuit is also identical to that used in the tag, incorporating the same enhancements to improve self-noise and hence range. The power supply is also identical, running from a pack of 4 standard alkaline AA cells.

To enable the system to be easily deployed on vessels of all sizes, the SLU has been designed to have a wireless interface to the device hosting the location app. Hence, the SLU can be attached wherever there is convenient for access to the sea and being in a waterproof housing there is no concern about rainwater, or seawater spray. The device hosting the location app can then be used anywhere on the vessel, without being limited by cable length or managing cables on a congested deck space. Figure 3 shows an example of the SLU deployed on UNEW's research vessel.



Figure 2. Production NETTAG+ SLU (left) with production tags (right).

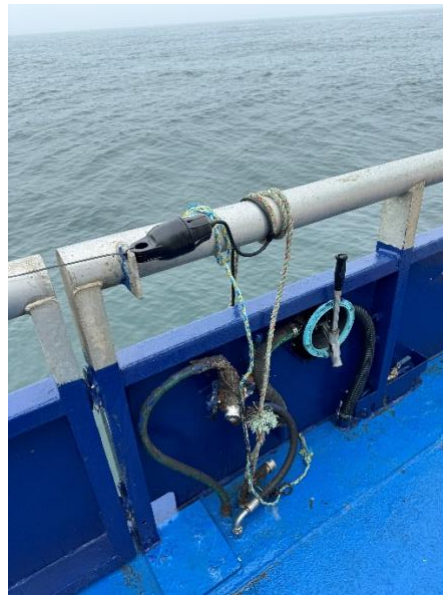


Figure 3. Example deployment of wireless SLU (with transducer over the side).

2.2 Wireless connection

The SLU communicates between the NETTAG+ transceiver and IOS / Android App using a wireless connection with sufficient range to cover the vast majority of fishing vessels. This is a critical part of the system, enabling the data to be displayed and trilateration algorithm to run on a handheld tablet or smart phone, utilising the onboard GPS receiver for the surface position reference as described in [1]. Bluetooth 5.4 was selected for its robust communication protocols, low energy consumption (longer battery life) and large operating range. Bluetooth 5.4 achieves 4x higher range than previous Bluetooth standards achieving up to 240 m.

A custom circuit board, pictured in Figure 4, was designed including the Bluetooth 5.4 transceiver module and a compact PCB antenna to minimise component cost and enable it to fit inside the limited space of the SLU housing. A logic level serial interface connects to the NETTAG+ acoustic transceiver circuit and commands/data responses are passed through transparently between the location app and the acoustic transceiver.



Figure 4. Bluetooth wireless interface board used in production wireless SLU.

2.3 Directivity enhancement

A possible enhancement to the design of the SLU is to introduce more directivity to the transducer in the vertical plane using a vertical “stave” of transducers. The benefits of this, compared to the standard single element (near omnidirectional) SLU device are:

- Higher output power (acoustic source level) on the interrogation signal sent out to the tag(s). This occurs by concentrating radiated sound in the direction it is most needed (near horizontal).
- Improved signal to noise ratio on reception of the tag response signal due to attenuation of sound received from the surface/vessel.

The transducer would remain omnidirectional in the horizontal plane so that tags in all directions can be interrogated without any alignment/steering of the transducer being required. However, if the radiated beam is too narrow in the vertical plane, then problems can also occur with alignment if the device is tilted e.g. by current. Hence a prototype device with a 3-element stave (pictured in Figure 5) was constructed with a vertical beam width of approximately 30 degrees.



Figure 5. Directional SLU transducer element deployed alongside standard omnidirectional SLU.

The performance of the directional SLU prototype was assessed in a trial in the North Sea alongside the standard “single element” SLU. A tag was deployed on a mooring and it was interrogated in turn by both SLUs as the host vessel drifted slowly from almost zero range to a maximum of 2.7 km range. Figure 6 shows a plot of the results obtained, indicating that the directional element offers a measurable increase in ranging success rate particularly at the longer ranges. The overall success rate (averaged over the whole range) increased from 84% for the standard SLU to 87% for the directional SLU. The increased success rate at longer ranges (2km +) also suggests that the directional element could increase the maximum range in suitable propagation conditions.

However, this modest increase in reliability/range must be balanced against the increased component cost/complexity of assembly of the 3 element stave device in the context of a highly cost-sensitive product. It is estimated that the directional transducer would add at least 100 Euro to the price of the final SLU product.

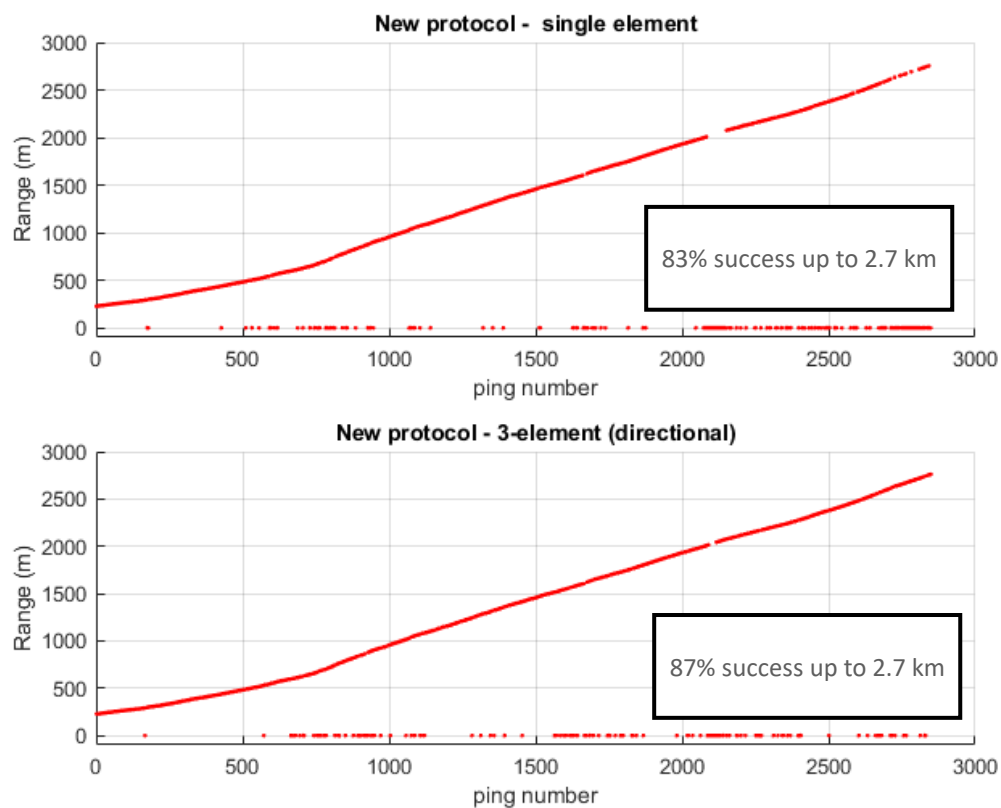


Figure 6. Comparison of ranging performance for standard NETTAG SLU and directional SLU (a dot at non-zero range indicates successful range measurement, a dot on the x axis indicates that a response was not received).

3 App development and tag management tools

3.1 Location algorithm and app

The mobile app for running the location process, position calculation and display has been developed collaboratively between UNEW and SF's Mobile App Development team. The app has been developed to run on the ubiquitous IOS and Android operating systems used on Mobile Phones / Cellular services and Tablet based devices (equipped with GPS receiver). The team wireframed the initial concepts and followed on with SF's internal mobile application development processes in line with current IOS and Google / Android platforms. Pre scan and development criteria verified by design to enable successful and easy migration from Test Flight development environment into the App Store and Android equivalent stores.

Figure 7 below shows screenshots from an Android mobile phone running the location app, illustrating each stage of the process of locating a tag.

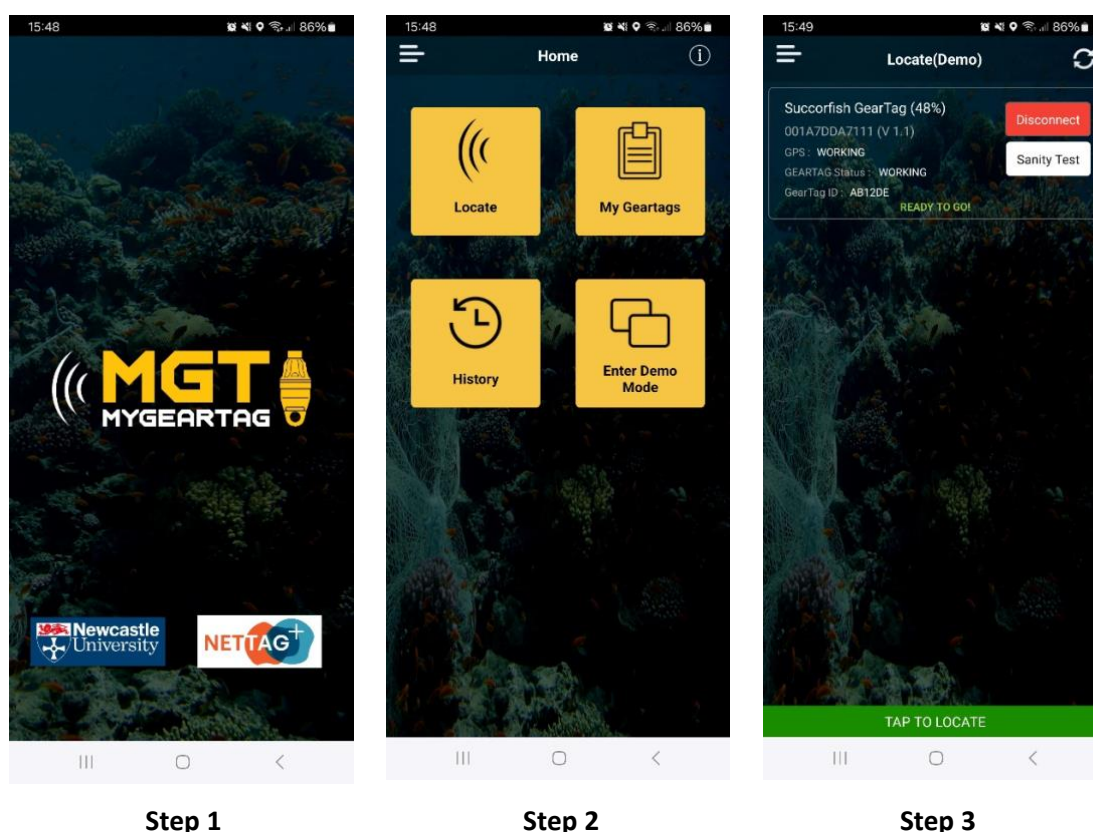
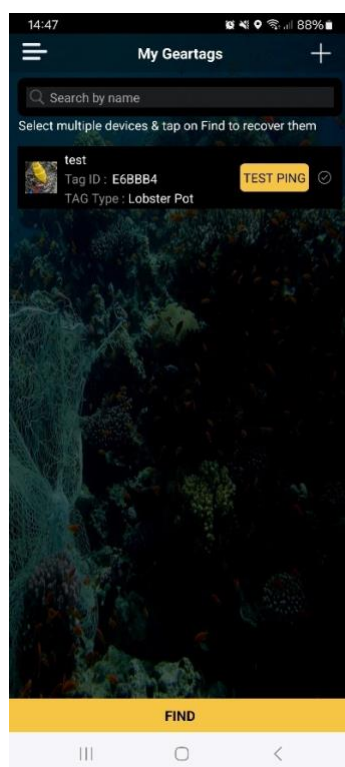


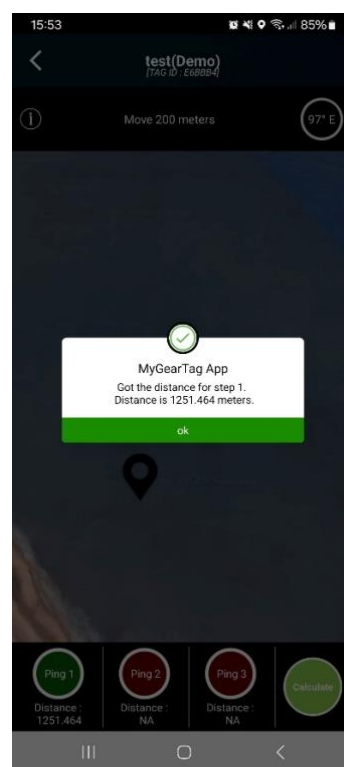
Figure 7. Android smartphone screenshots showing stages of locating a tag using the app.



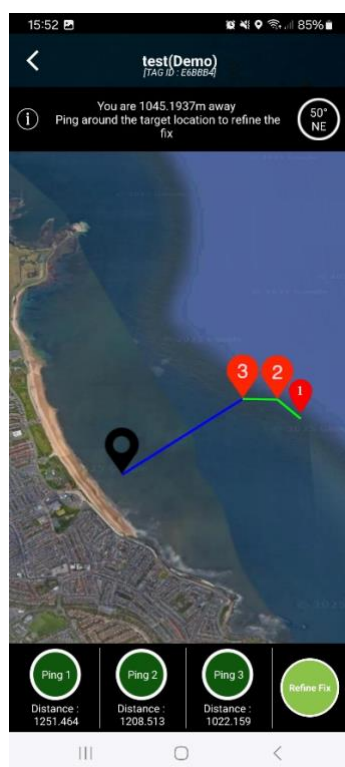
Step 4



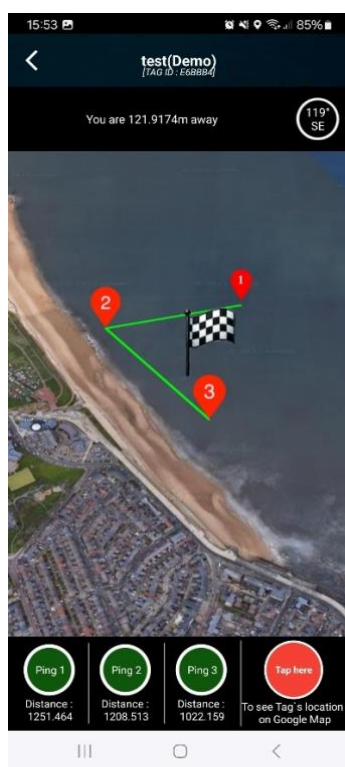
Step 5



Step 6



Step 7



Step 8



Step 9

Figure 7 (cont.). Android smartphone screenshots showing stages of locating a tag using the app.

The steps are as follows:

- Step 1: Opening the app.
- Step 2: Select the Locate function.
- Step 3: Connect to SLU via Bluetooth and test connection.
- Step 4: Select tag to find from list of registered tags.
- Step 5: Select “find” and follow instructions until first contact (range) is obtained.
- Step 6: Click on tag in radar view or list view then follow instructions to locate.
- Step 7: After obtaining ranges from 3 positions first position estimate (Latitude, Longitude) is obtained.
- Step 8 (optional): Select “refine fix” to range from 3 positions around the first estimate and obtain a highly accurate position.
- Step 9 (optional): Display position on Google map (detailed background imagery only available when the device has an internet connection).

Depending on the range of the first contact and the geometry of the 3 positions used for the first position estimate, the first estimate can be accurate enough to attempt recovery of the gear. However, it is generally recommended that the refined estimate is obtained in order to be able to place the vessel within a few m of the gear position (as demonstrated in [1]).



Figure 8. Alternate view of app on IOS tablet.

The app is fully scalable to different mobile platforms from smartphones to larger tablet devices such as that shown in Figure 8.

3.2 Tag registration, management and data storage

Each tag is manufactured with a 24-bit identification code enabling 16.8 million globally unique addresses. This code is derived from a longer serial number encoded at manufacturing time in the microprocessor devices used in the tags. To be able to locate any tag, you must have its unique code so that the SLU can transmit the correct interrogation message (the tag will not respond to any other address). Hence fishers need to register each tag they own within the app so that the codes are stored.

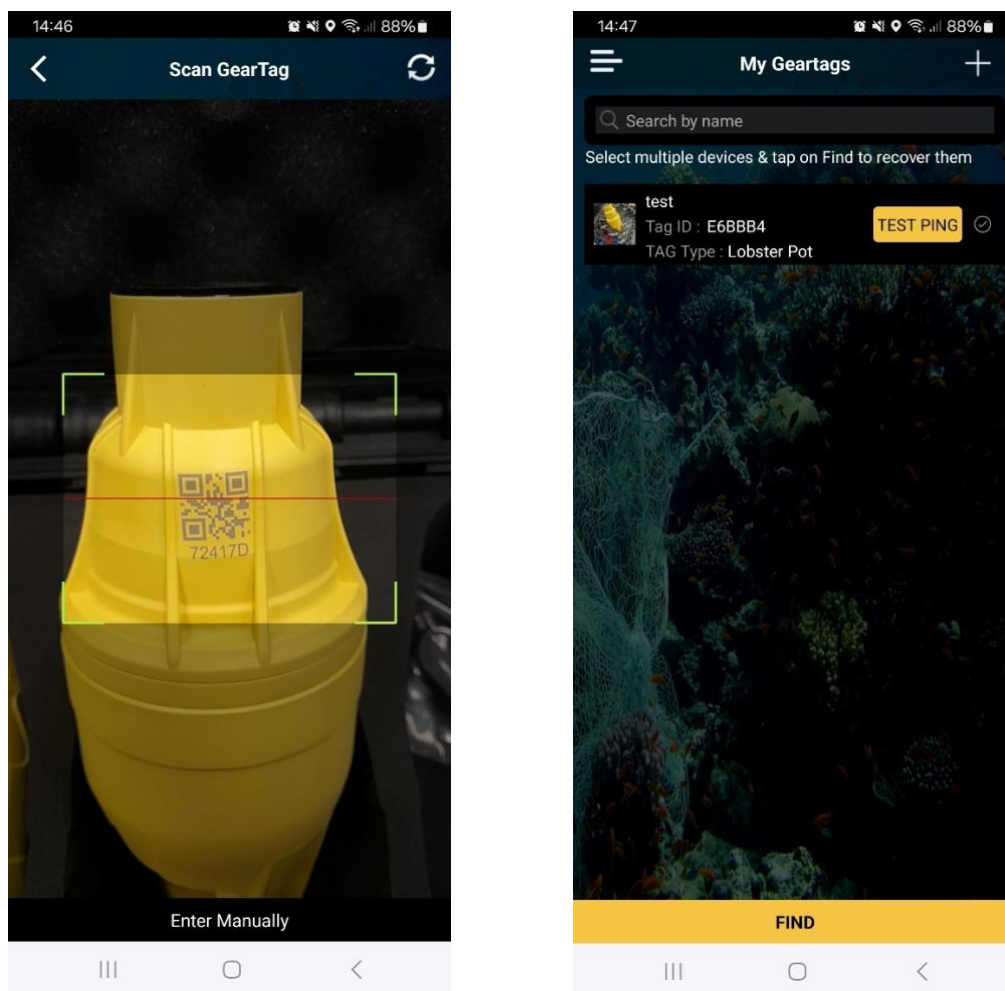


Figure 9. Automatic registration of tag using QR code.

To do this efficiently the code is laser etched as a QR code on each tag manufactured (a water-resistant printing process). In the app, the code can be manually entered or, for convenience,

the camera on the mobile device can scan in the QR code as shown in Figure 9. Other optional data can be entered for each tag including:

- Name
- Gear type
- A photograph of the tag and/or gear

Any number of tags can be registered and stored and they will appear when selecting the My GearTags function (step 2 above). Each time a tag is interrogated and/or located the data is stored under the history tab as shown in Figure 10 and this data can be exported from the app for further analysis (or to help technical support).

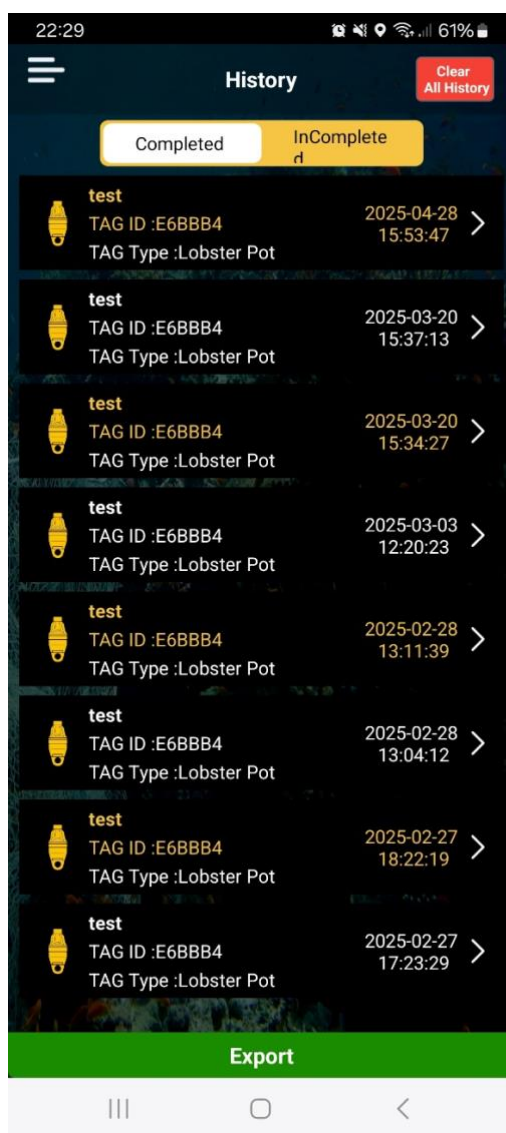


Figure 10. History function for tag location data storage and export.

4 Initial system field testing

The absolute accuracy of ranging and the trilateration process was verified during the original NetTag project and so initial testing of the full production NETTAG+ system (tags, SLU and app) has focused on proving the utility of the system in fishing operations, and on a variety of vessels and geographical locations. UNEW and SF have conducted several successful trials onboard vessels in:

- the North Sea (UNEWs research vessel)
- North Atlantic (Canadian lobster fisheries)
- Indian Ocean
- Mediterranean
- Canary Islands



Figure 11. Examples of system field testing in North Atlantic (left) and North Sea (right).

This is the start of the process of evaluating the technology and understanding how it is best applied on different gear and in different fishing operations, which will continue in Task 3.5 for the remainder of the NETTAG+ project and be reported in detail in the upcoming D3.5.

5 Conclusions

The NETTAG+ SLU has been developed to TRL 8 and is now in production by Succorfish, along with the tags, under the product name MyGearTag. An enhanced prototype SLU device with directional transducer has been designed and tested, but although a small improvement in range/reliability is possible, the additional cost/complexity was not justified for the production system (given the highly cost sensitive application). Production software for the Android and IOS compatible app is available for download and this connects wirelessly to the SLU via Bluetooth. The app provides a user-friendly and intuitive interface and seamless registration/management of tag devices, along with the ability to store and retrieve positional data. Systems are starting to be evaluated in real fishing operations and this will be scaled up during the remainder of the project, to obtain feedback on operability and performance, guiding further refinements to the hardware/packaging, app and user instructions.

6 References

- [1] EASME/EMFF/2017/1.2.1.12/S2/02/S12.789121 Deliverable D3.2 – Acoustic Locating System
- [2] HORIZON-MISS-2022-OCEAN-01 NETTAG+ deliverable D3.1 – Enhanced Transponders



7 Acknowledgements



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