Practical implementation of real-time fish classification from acoustic broadband echo sounder data- RealFishEcho progress report

Year 1 – June 2017

Authors: B. Berges, S. Sakinan, E. van Helmond

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Author(s): B. Berges, S. Sakinan, E. van Helmond

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Client: Redersvereniging voor de Zeevisserij (RVZ)
Louis Braillelaan 80
2719 EK Zoetermeer

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Contents

Summary

The EU has by means of new policy restricted the discarding of fish at sea, including bycatch and slipping. As a result, the fishing industry now requires improved methods to identify fish species and size before the catch process begins. With the introduction of robust broadband echosounder (i.e. downward looking sonar) on the market, active acoustic data now have the potential for improved target discrimination for both type and size (i.e. determine fish species and size).

The aim of this project is to develop methods for fish classification and size estimation using data from broadband echosounder and further implement them into a software for near-real time viewing. Such a software would help skippers to take better informed decisions while fishing.

This project is running over three years (June 2016 to June 2019) in collaboration between Wageningen Marine Research (WMR), Redersvereniging voor de Zeevisserij (RVZ) and TNO. This document is a progress report for the first year of the project.

In short, while hampered by issues in data collection and recent change in staff in WMR (departure of project leader), good progress has been made on the project.

Europese Unie, Europees Fonds voor Maritieme Zaken en Visserij

1 Introduction

The EU has by means of new policy restricted the discarding of fish at sea, including bycatch and slipping. As a result, the fishing industry now requires improved methods to identify fish species and size before the catch process begins. With the introduction of robust broadband echosounder (i.e. downward looking sonar) on the market, active acoustic data now have the potential for improved target discrimination for both type and size (i.e. determine fish species and size).
The aim of this project is to develop methods for fish classification and size estimation using data from broadband echosounder and further implement them into a software for near-real time viewing. Such a software would help skippers to take better informed decisions while fishing.
This project is running over three years (June 2016 to June 2019) and is divided into 5 work packages (WP):

- WP1: system calibration.
- WP2: Data collection.
- WP3: Data processing and analysis.
- WP4: demonstrator software development.
- WP5: management, communication and reporting.

The project runs in collaboration between Wageningen Marine Research (WMR), Redersvereniging voor de Zeevisserij (RVZ) and TNO. The data collection is carried out by three commercial freezer trawlers:

- SCH24 Afrika
- SCH6 Alida
- SCH302 Willem van der Zwan
- Research vessel “R/V Tridens” through data of opportunity collected during acoustic surveys conducted by WMR.

Each vessel in this study is using an EK80 system running in Frequency Modulated mode (FM, named “EK80 FM” further in this report), i.e. broadband. This is to differentiate with the EK80 running in Continuous Wave mode (CW, named “EK80 CW” further in this report), narrowband. The EK80 system is provided by Simrad.
This document is a progress report for the first year of the project and is gives an update for each WP. In the following sections, highlighted text in grey ( ) are tasks that were undertaken or future tasks. In short, while hampered by issues in data collection and recent change in staff in WMR (departure of project leader), good progress has been made on the project.

1.1 Key technical points

In fisheries, commonly used acoustic systems for scrutinizing fish are echosounder (Simmonds & MacLennan, 2005). These are downward looking sonars that have been used for decades, especially Narrowband systems. Through recent technological development, the EK80 echosounder is now available commercially and is able to work in broadband. This offers benefits in term of species identification, the focus of this project.
Section 2 (WP1) of the report presents the work undertaken for the systems calibration. Calibration is an important step of the acoustic data collection process. It enables the echosounder to provide absolute acoustic measurements. This is paramount for the consistency of the data collected but also the consistency between different platforms (differences between echosounders and background conditions). Echosounder calibration has been very topical for the last 30 years and remains an important topic in the scientific community (Demer et al., 2015) in an effort to provide standardized procedures (K. G. Foote, Knudsen, Vestnes, MacLennan, & Simmonds, 1987; Kenneth G. Foote et al., 2005). The most commonly used procedure involves the use of standard spheres (given size and material properties). With such a target, the acoustic response at various frequencies can be calculated theoretically (MacLennan, 1981) and provide the base for the correction needed for each individual echosounder. The calibration procedure is generally performed in advance of the data collection, at least once per year.

Reliability of the species classification and size estimation algorithms depends on the accuracy of the calibration. While standard instruction procedures are provided by the echosounder manufacturers, experience and knowledge are needed when assessing the quality of the results. Furthermore, while procedures for narrowband systems have been refined for the last 30 years (Demer et al., 2015; K. G. Foote et al., 1987), calibration procedures for broadband systems (e.g. EK80 FM) are still under development and require further and more elaborate efforts. In addition, calibration on commercial vessels is more time consuming and can be particularly challenging for the crew who are not very familiar with these operations. However their involvement is highly desired. On this point, some progress had been achieved by WMR in the last years with projects involving Dutch pelagic trawlers (Fassler et al., 2015). However further progress is needed to make the fishing vessels fully autonomous in terms of data collection with adequate data quality, especially for the EK80 FM.

1.1.1 Calibration requirement

Echo sounders generate sound waves by converting electrical energy to acoustic energy. This conversion is performed by the acoustic transducers. The core of the transducers are some specialized units called piezoelectric elements. When electrical power is applied to these units, they vibrate and create sound waves in the water. Subsequently, the sound echoes back from various targets in the water column. These acoustic waves are sent back to these piezoelectric elements that convert this acoustic signal into and an electrical signal. Hence, echo-sounding process involves generating some precise amount of electrical power and record the generated electrical power. In short, the acoustic data is basically the amplitude time series of these recorded electrical signals.

Although the acoustic waves transmitted in the water are strong, a large portion of the energy is lost in the water column as the wave travels further away from the source. The magnitude of the returned signals are substantially weaker. In order to detect these weak signals, echosounders are designed to be extremely sensitive. To maintain this sensitivity and accuracy, it is necessary to test the equipment periodically. Manufacturers (e.g. Simrad) provide details about the theoretical performance of a given echosounder. Though, these instruments are susceptible to variation due to aging, changing ambient temperature or other factors such as varying electric/electronic hardware setup in the vessel. Furthermore, there is also variations for a given echosounder model between different vessels (e.g. due to background noise). The species classification method used here relies on the absolute acoustic scattering from fish schools and small biases in the instrument may cause large error in the estimations and classification efforts. Therefore, calibration is necessary for good performance.

1.1.2 Properties of the transducer and gain

In acoustics, the magnitude of the received signal is calculated relative to the signal sent. It is very important to account for any deficit (such as transmit loss) or surplus (such as noise) in the energy budget. This is done using the SONAR equations (Urick, 1996). The absolute magnitude of the received signal relative to the sent signal is calculated through correction for: (1) the transmission losses and (2) equipment specific correction (i.e. calibration). The overall resulting compensation required is referred as the gain. There is two types of gain: “time varied gain” (TVG); “transducer gain”.

TVG accounts for the loses due to the spreading of the sound and absorption in the water column. This correction can be calculated accurately using theoretical expression, given the environment factors are known (temperature, salinity, depth) (Ainslie & McColm, 1998; Lurton, 2010; Simmonds & MacLennan, 2005).

As for “transducer gain”, it can only be determined experimentally. This quantity provides the relationship between measured electrical signal and corresponding acoustic intensity. More specifically, conversion between electric and sound is never 100% efficient and part of the energy is also lost within the instrument when receiving and transmitting. Similar losses happen when the returning sound is being converted back to electrical energy. Normally this gain factor is provided by the manufacturer for a given model. However it is necessary to account for the potential variations over time and between vessels.

1.1.3 Methodology

An echosounder system is composed of 4 main units: the transducer (converting electrical power to sound and sound to electrical power), the transmitter, the receiver and a computer. The computer communicates with the rest of the system only digitally and has no effect in the variations. Modification in the transmit/receive unit may have effect in the energy budget. However, the main potential source of variation is the transducer. The magnitude of the variations can be different between the vessels and calibration performed on one vessel cannot be applied on a different vessel. Each calibration is performed separately. The standard calibration method is to use a reference target with known reflectivity. These reference targets are spheres of known acoustic characteristics such as copper or tungsten spheres of a given size (K. G. Foote et al., 1987). During the calibration procedure, these spheres are lowered into the water and positioned under the transducer. By measuring this reference sphere, the deviation from the expected values are measured and the correction factors are calculated.

1.1.4 Transducer gain

The first task for calibration is the calculation of the transducer gain. This is done through comparison with the theoretical response from a calibration sphere, after correction of acoustic losses in the water column (e.g. spreading and absorption). The result of this comparison is the amplification needed in order to provide absolute acoustic intensity. This is the “transducer gain”. With a calibrated transducer gain, the absolute amplitude of the returning sound signals can be calculated. Ideally, after these TVG and transducer gain corrections, the acoustic intensity provided by the echosounder should be comparable, regardless of the vessel, ambient temperature or location.

1.1.5 Beam pattern

The Second task of the calibration process is the calculation of the geometry of the acoustic beam. Echosounders create directionally focused sound beams in a cone with a narrow opening angle. The angle of this conical beam depends on the design and is tipically specified by the echo sounder manufacturer (e.g. 7^0 at most frequencies for the EK80). However due to e.g. temperature or aging, there may be alterations in the beam pattern. It is important to know the beam pattern of the echosounder because the acoustic intensity varies depending on the position of a given target in the beam. For example, a fish at the centre of the beam will give a stronger acoustic response than if it was closer to the edge of the beam. The beam pattern calibration provides the necessary correction factorfor this.
The beam pattern calibration is carried out at the same time as the gain calibration. The metal sphere is brought to the center of acoustic beam then moved across the beam for a full coverage of the beam patter. Measurements at different locations inside the beam provides the beam directivity and beam pattern correction.

1.1.6 Calibration for the EK 80 FM (broadband)

The calibration of the simrad EK 80 FM is more complex than for narrow band echosounders (e.g. EK60, EK80 CW). The EK 80 FM provides active acoustic measurements across continuous large frequency bands. During the calibration, the challenge is to maintain accuracy and sensitivity over the entire frequency band rather than focusing on discrete frequencies. Calibration has been a straightforward task for the earlier generation echo sounders (narrowband, e.g. EK60, EK80 CW) because corrections for transducer gain and beam-pattern characteristics were needed only at one frequency per channel. However for a broadband system, one need to cover the entire frequency range instead of discrete frequency points. In addition, the use of calibration spheres for the coverage of the full frequency range has one main drawback. The acoustic response from a given calibration sphere has regions of the spectrum that are not usable because the acoustic intensity is predicted to be infinitesimally small due to the phase cancellation. In practice, one is unable to infer calibration gains in these regions. Therefore, a combination of different calibration spheres is needed in order to

cover the entire frequency range for a broadband system. Typical calibration spheres used are Tungsten Carbide spheres of size: 22 mm, 25mm and 38.1 mm.
Because the EK80 FM is relatively new, it is important to dedicate effort on further validation of the calibration procedures provided by the manufacturer Simrad.

2 WP1: Calibration

2.1 Introduction

The calibration procedures for the Afrika (SCH24) and Alida (SCH6) were performed in August 2016. Because of issues with one of the transducers, calibration for the Willem van der Zwan (SCH302) could not be performed. Calibration for the Tridens was performed in June 2016 (WMR). The standard method for echosounder calibration was used and results were produced using the EK80 calibration software and custom MATLAB code.

2.2 Work undertaken and current state of WP

2.2.1 Afrika (SCH24)

- There were complications with the calibration results initially delivered to WMR. This was because of missing gain for numerous frequency bands. There was also missing data for the 200 kHz channel. Because of the previously mentioned issues associated with broadband capabilities of the EK80 FM, substantial effort was needed to investigate and reanalyze the raw data from the Afrika (SCH24) using custom code (WMR). Standard calibration spheres were used for the calibration and the procedure is explained in Section 1. Figure 2.1 shows the results of this calibration procedure. First, Figure 2.1(a) shows a typical calibration echogram. Then, Figure 2.1 (b) shows the frequency characteristics of the returning sounds from the calibration sphere. For the EK 80 FM, the frequency coverage is continuous over large frequency bands. The blue continuous curve is the theoretical response (MacLennan, 1981) while the straight black line is the measurement from the echosounder. The red areas correspond to frequency bands that are not useable for the calibration sphere. This is because of the dips in acoustic intensity that cannot be accurately measured. In order to cover for these areas, different calibration spheres are required. The difference between prediction and measurements in different frequencies bands are used to infer the corresponding calibration factors. Figure 2.1(c) shows the resulting gains as a combination of calibrating the system using 3 spheres: 22 mm Tungsten Carbide, 25 mm Tungsten carbide, 38.1 mm tungsten carbide.
- The calibration gains are now available for the Afrika (SCH24) on all channels.

2.2.2 Alida (SCH6)

- Calibration of the Alida (SCH6) was overall successful therefore there is no specific issue that is necessary to report (WMR).

2.2.3 Willem van der Zwan (SCH302)

- Calibration of the Willem van der Zwan is problematic. Entire calibration effort was failed because of a pending issue with the 120 kHz transducer. The problem has been solved now and the calibration will be performed soon.

2.3 Work planned for the following reporting period

- Integration of the calibration results using the ECHO software (TNO)
- Willem van der Zwan calibration: In accordance with client (RVZ), owner and crew of Willem van der Zwan make a plan for calibration (WMR).

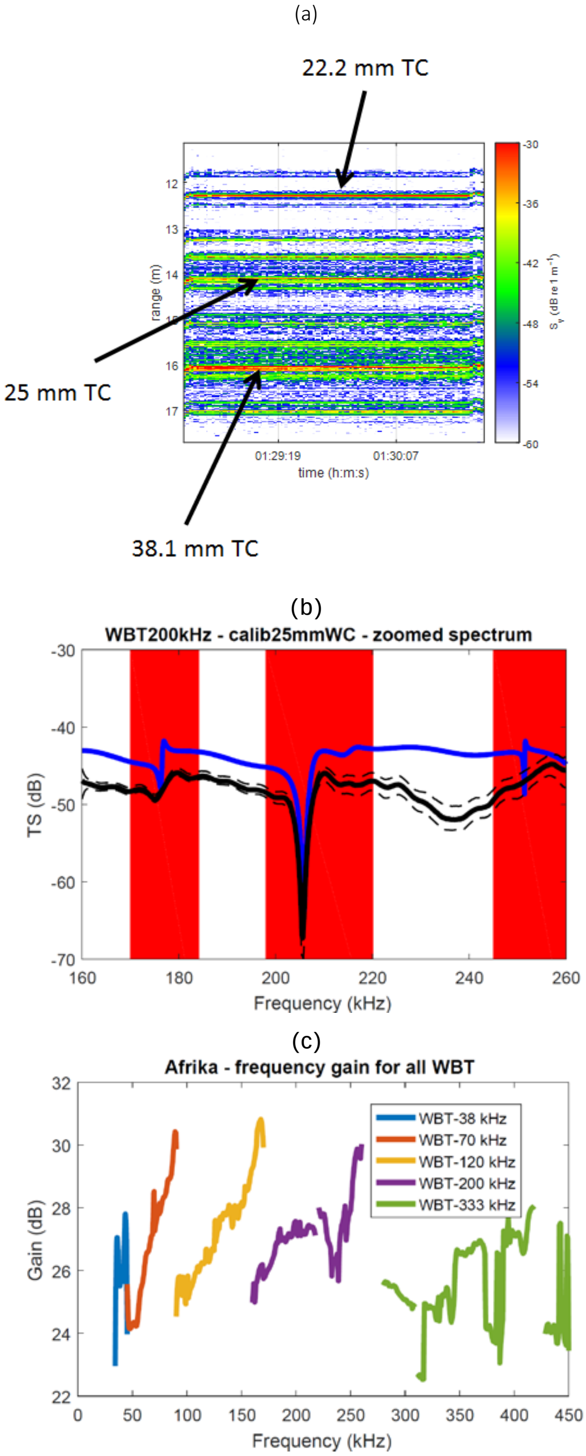


Figure 2.1: *procedure used to re-compute calibration gains for the EK80 FM installed on the Afrika (SCH24). (a): Typical echogram (echo intensity from one echosounder channel, across time and range) for the EK80 FM system during calibration. The echo from the different calibration targets can be observed at various depths: 22.2 mm Tungsten Carbide (TC) sphere, ~12 m depth; 25 mm TC sphere, ~14 m depth; 38.1 mm TC sphere, ~16 m depth. The acoustic frequency response of the spheres is measured by each EK80 transducer and is analysed in order to obtain the calibration. (b): Frequency response for the 38.1 mm TC sphere. The blue line is the theoretical frequency response computed from material properties and the solid black line is the mean of the measurements. The dashed black lines are the 75% and 25% percentiles. The deviation between the theoretical results and the measurements provides the correction in gain. (c): Gain levels versus frequency after analysis from the raw files for the different EK80 channels available.*

3 WP2: Data collection

3.1 Introduction

Within the first period of the project, EK80 FM data were collected on research vessel “R/V Tridens” and collaborating commercial vessels Afrika (SCH24) and Alida (SCH6). These data are being processed and converted into a specific database format for the analysis of fish acoustic signatures. It is also used to construct the training set to be used for the classification algorithms.
The vessels involved in the data collection have different setups in term of frequency channels, with a minimum of 3 frequency channels (70, 120 and 200 kHz) up to 5 channels (38 kHz, 70 kHz, 120 kHz, 200 kHz, 333 kHz). Because data from all vessels contain at least data for the 70, 120 and 200 kHz channels, only these frequencies channels are being used as a basis for the classification algorithms. For each data set, trawl catch are also being recorded in order to provide grounthruth for the acoustic data. Ideally, this should also include fish length measurements.
Data collected to date includes 2 herring surveys with R/V Tridens (July 2015 and July 2016) and data from fishing trips of Alida and Africa from 2016 and 2015 for horse mackerel and herring.
The project experienced some communication problems among scientific team and the skippers of the commercial vessels, leading to a low amount of data collected from commercial vessels. However this situation has been improving after holding various meetings. Efforts have been made to resolve the issues arising from the extra responsibility on the skippers, especially due to the SEAT[1] project which has a similar context and the data collection requirements. Further efforts will be made on this point in the next period.

3.2 Work undertaken and current state of WP

- The current state of data available to WMR and TNO is presented in Table 3.1. It is important to note that no data is available from the Willem van der Zwan (SCH302) because of issues with one of the transducers. This has been fixed recently and data will be collected shortly.
- Only one dataset has been collected since October 2016. This was mainly due to a miscommunication between WMR and the skippers of the commercial vessels.
- Data collection is particularly challenging for the skippers because they need to collect EK80 data for the RealFishEcho project and for the SEAT project. Each project have different requirement in term of settings for the data collection. The RealFishEcho project requires EK80 FM data while the SEAT project requires single-band data on all frequencies. More regular contact with the skippers will be held in the future to help the data recording (WMR).

3.2.1 Mitigation

- Actions were taken to fix the lack of data collection: (1) setting up predefined settings for the EK80 software; (2) installing the record data version of the ECHO software onboard the Afrika (see Section 4, TNO). The software provides an easy way for the skipper to perform and control data collection. In addition, a manual for data collection is currently being written (WMR). If successful on the Afrika, this procedure will be replicated on other vessels if needed.

[1] SEAT: School Exploration and Analysis Tool. See: *Sustainovate 2017 Improved Selectivity of Small Pelagics iun the North Sea & North Atlantic Using SEAT*

date	scrutinized	species composition available	length distribution available	main species	number of files displaying a fish school
Alida					
October 2016	yes	yes	no	HOM	85
August 2016	yes	yes	no	HER	100
October 2015	yes	yes	no	HOM	228
Tridens					
July 2016	yes	yes	yes	HER	25
July 2015	yes	yes	yes	HER	196
Afrika					
December 2017	no	yes	yes	HER	-
August 2016	yes	yes	yes	HER	152
Willem van der Zwan					
no data (issues with transducers)					

Table 3.1: *data sets available to WMR and TNO, advancement of data quality assessment. An overview of size for each data set is also provided (number of files where a fish schools was observed). This step provides the input information necessary for the classification step. It is important to note that each EK80 files only cover ~2 minutes of data. As a result, fish schools are typically imaged across consecutive EK80 files. These are data of opportunity as data collection for this project is a secondary task. Corresponding maps where data collection was carried out are shown in Figure 3.1 to Figure 3.5.*

3.2.2 Further data requirement

- At this point in time, the project needs more diversity in the data. As it can be observed in Table 1, the main species investigated to date are Herring and Horse Mackerel. It is critical to collect data for the following species:
  - Mackerel
  - Boarfish. This is an unwanted species and it is problematic during trawling for fishermen. For that reason, it is valuable to be able to discriminate it and acoustic recording of boarfish should be performed during these problematic trawls (for algorithms training purposes).

3.3 Next period:

- Further data collection, especially for Mackerel and Boarfish, possibly more blue whiting.
- Organize data from various vessels (WMR)

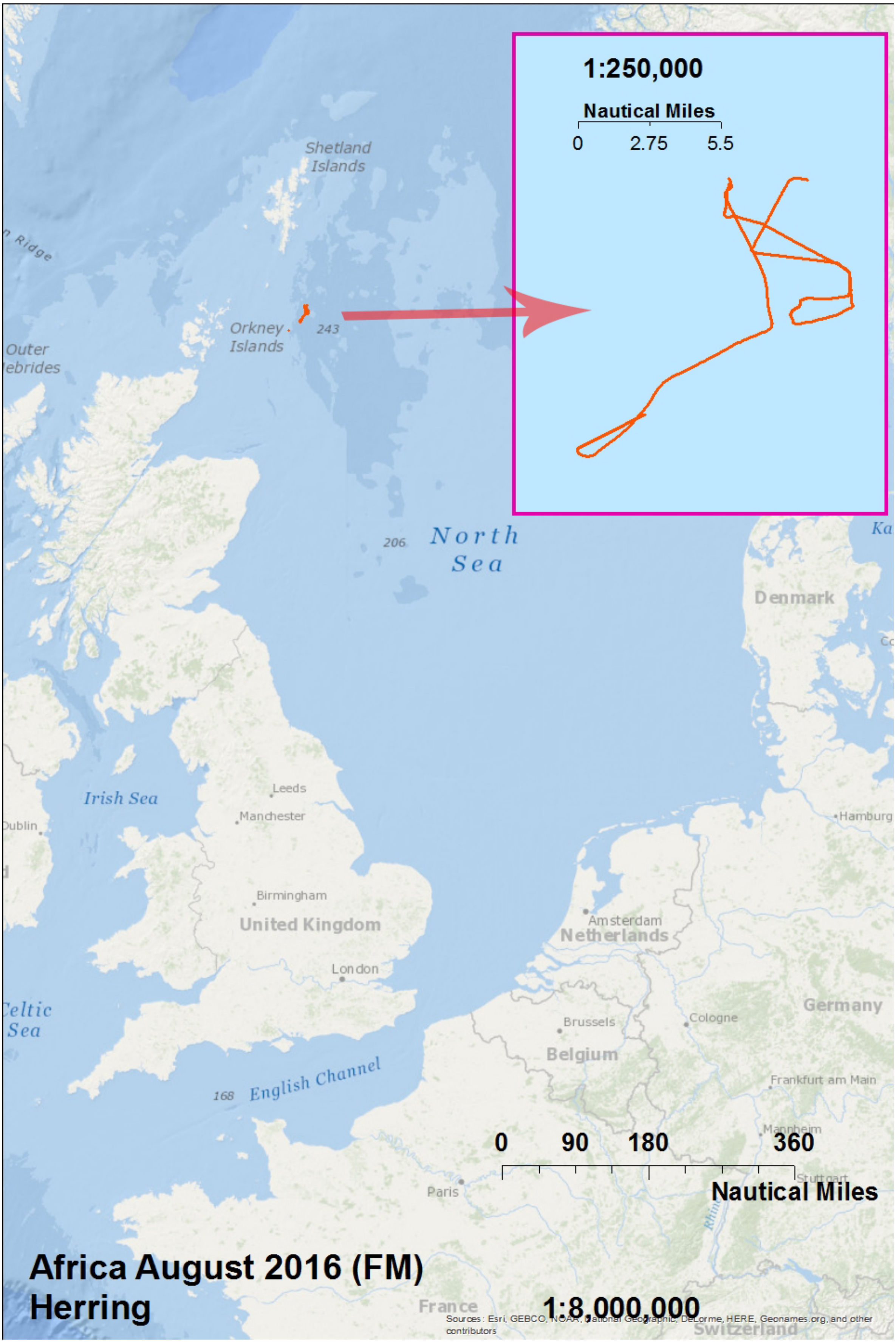


Figure 3.1: *vessel track during the collection of broadband data for the Afrika during August 2016 (herring fishing).*

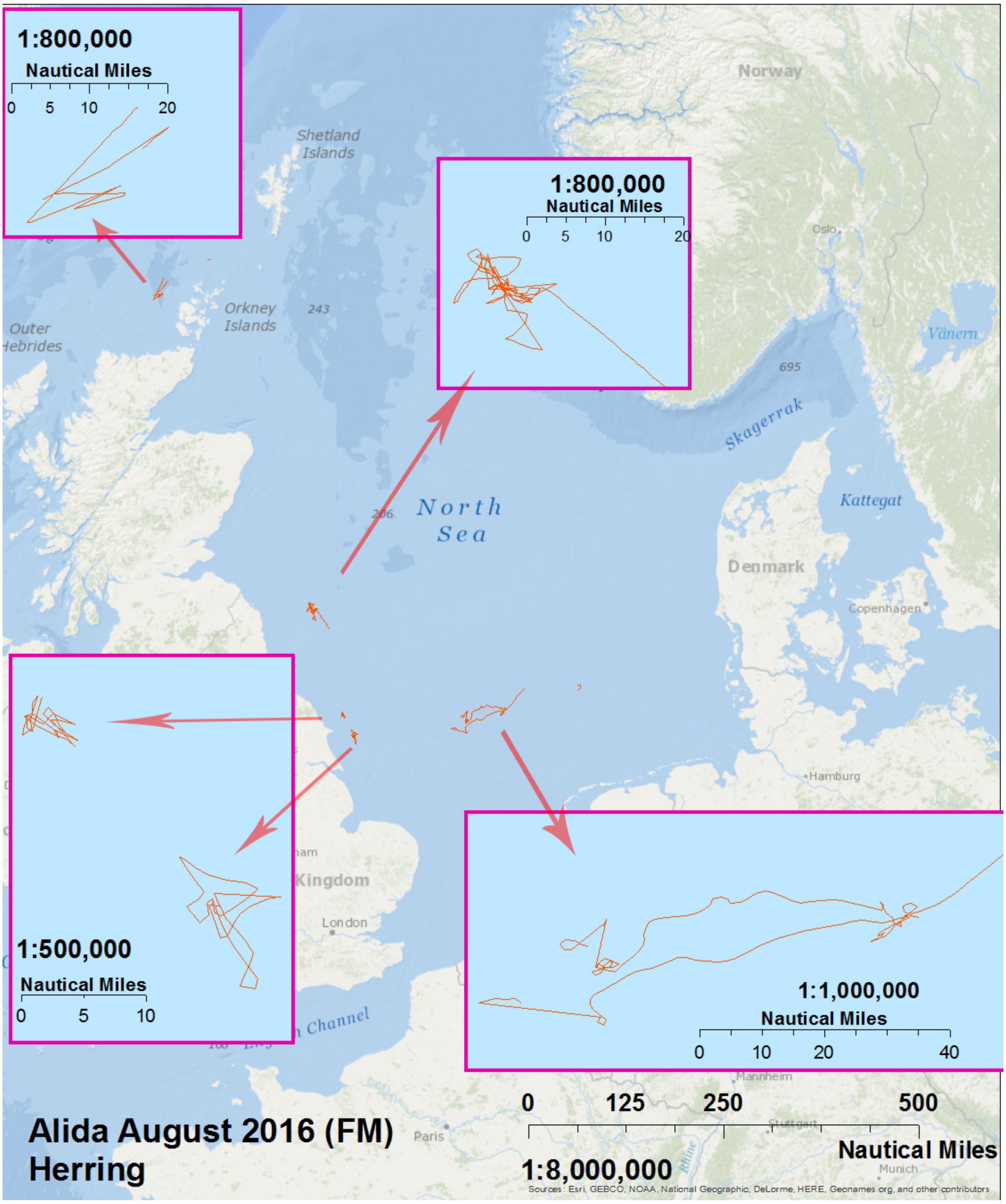


Figure 3.2: *vessel track during the collection of broadband data for the Alida during August 2016 (herring fishing).*

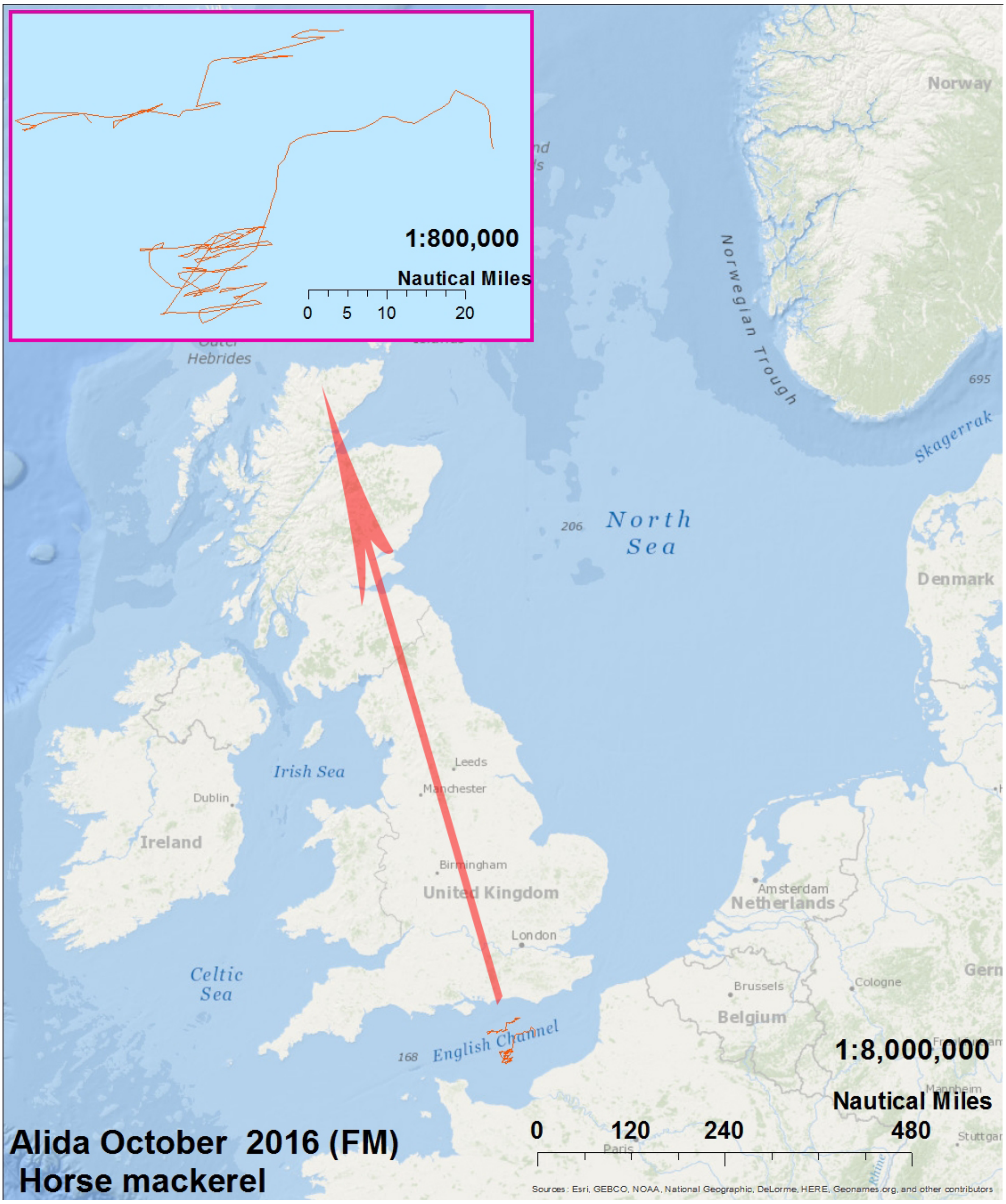


Figure 3.3: *vessel track during the collection of broadband data for the Alida during October 2016 (Horse Mackerel fishing).*

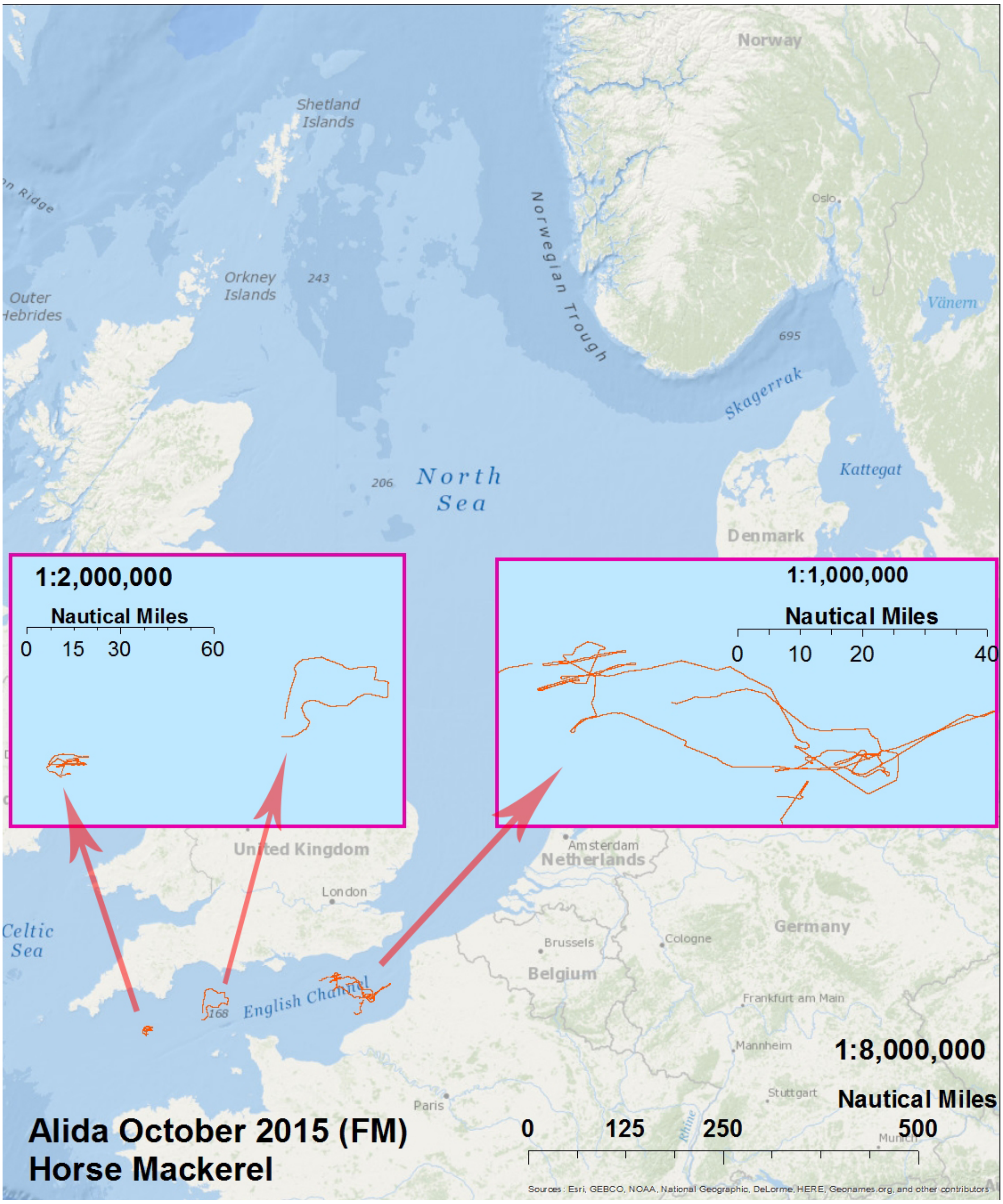


Figure 3.4: *vessel track during the collection of broadband data for the Alida during October 2015 (Horse Mackerel fishing).*

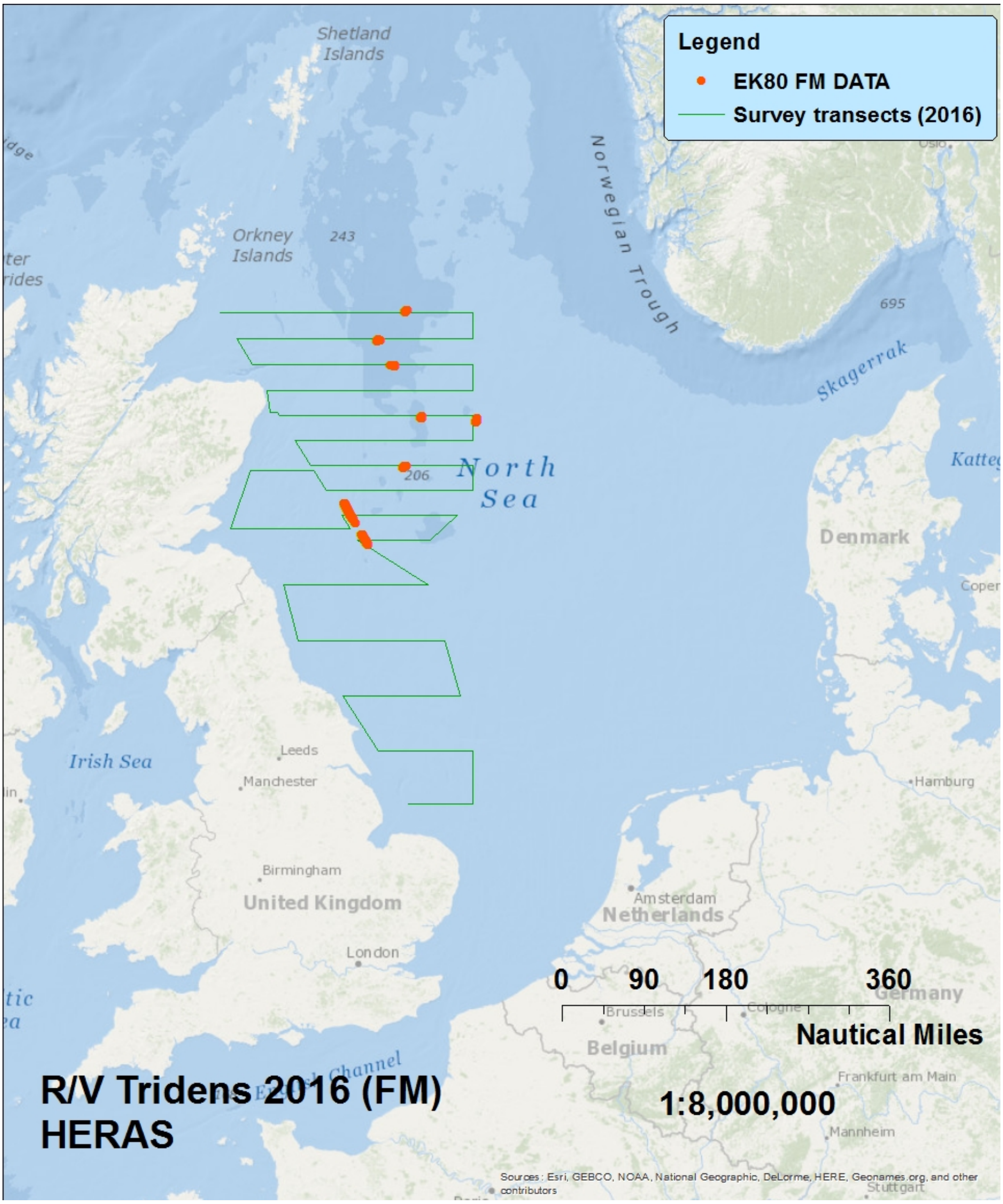


Figure 3.5: *vessel track during the collection of broadband data for the Tridens during July 2016 (Herring acoustic survey). Transects in green show narrow band transects and orange show broadband data collection.*

4 WP3: data analysis

4.1 Introduction

Data analysis is ongoing in parallel to the construction of the database. Due to the fact that the data analysis needs to be performed automatically near real time on-board, main efforts have been devoted to optimise these automation procedures. One of the difficulties was the format change in the raw data of the EK80 imposed by the manufacturer Simrad.

4.2 Work undertaken and current state of WP

- The format of the EK80 data was recently changed significantly by simrad and the code used to read raw data had to be adjusted in order to be able to read all types of files consistently (WMR & TNO).
- The datasets available (Table 3.1) were scrutinized, i.e. data files containing fish schools were identified (WMR).
- A report describing data organization and a database format has been drafted and is currently under review (WMR & TNO).

4.3 Future work:

- Convert available data to database format, including incorporating calibration data (WMR & TNO)
- Train classification algorithms with ground truth data (WMR & TNO)
- Perform classification tests on datasets in order to assess algorithms performances (WMR & TNO)
- Add new catch data to the database as soon as they are available to further improve classification robustness (WMR & TNO)

5 WP4: software development

5.1 Introduction

An initial version of the software is ready with some minor improvements and added functionalities. However currently it can only be used for near-real-time data visualisation. Tasks focusing on the implementation of classification algorithm is ongoing.

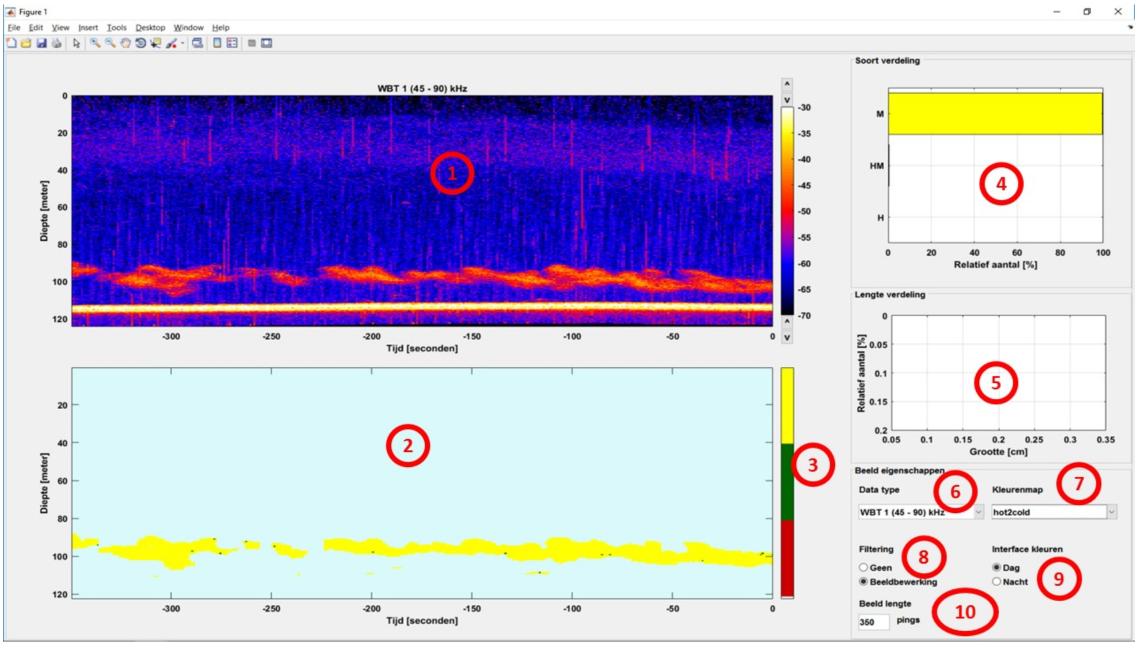
5.2 Work undertaken and current state of WP

- A Beta version of the ECHO software was presented to Jaczon and W. van der Zwan on 17/02/2017 (TNO). Currently, only the feature analysis algorithm (TNO) is implemented in the classification module. An additional classification algorithm (Neural Network) provided by WMR will be implemented in future version, for both species and length estimation. Figure 4.1(a) shows a screenshot of the software with a description of the various functionalities in the caption.
- The ECHO software, (implemented by TNO), has been updated in order to run close to real-time on board the Afrika during the data collection campaigns. This allows the skipper to quickly assess the data quality when recording the sonar data. The classification module has been disabled on the version running on board the Afrika, since the classification modules have not been trained yet (more data needed). Various controls of the sonar settings and parameters have additionally been incorporated in order to automatically give a warning to the skipper if they are incorrect (the EK80 sonar is used for the SEAT project as well and uses different settings, see WP2). This provides an extra security for the data collection. Figure 4.1(b) shows a screenshot of the software with a short description of its functionalities in the caption.
- Various minor software improvements and added functionalities (WMR & TNO)

5.3 Future work

- Develop full capability for the ECHO software (TNO)
- Implement Neural network classifier (WMR)
- Develop size estimation method (WMR)
- Train classification modules (TNO & WMR)
- Write software documentation (TNO & WMR)
- Deploy and evaluate ECHO software on board (TNO & WMR)

(a)



(b)

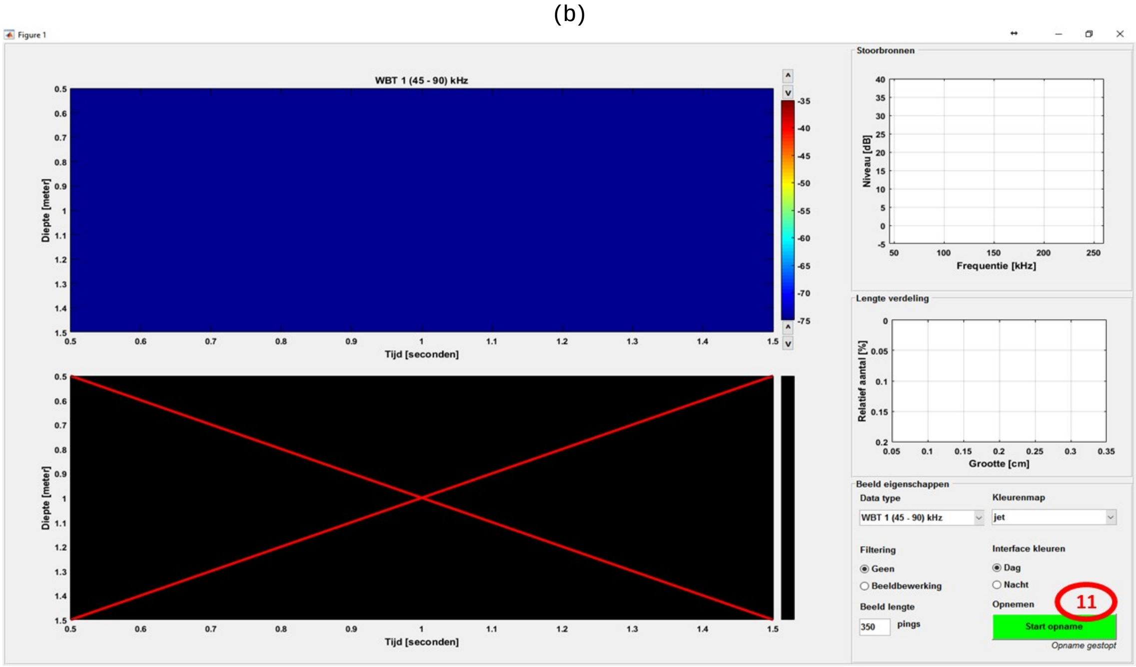


Figure 4.1: *screen shots of the two ECHO software versions implemented to date.*
(a): beta version of the ECHO software: (1) Echogram display; (2) Fish school detection and classification display with one colour per species (see colour bar (3)); (4) species composition in displayed echogram in % for each of the species (M: Mackerel, HM: Horse Mackerel, H: Herring, 100 % Mackerel here); (5) length distribution estimate (not implemented yet); (6): drop down menu with data type selection, as displayed in echogram; (7): echogram colour map; (8):echogram filtering; (9): day/night mode (i.e. interface background colour); (10): number of pings displayed in echogram.
(b): Screenshot of the ECHO software installed on the Afrika. This software version does not have any classification functionality activated yet. In this phase, it is solely used to filter data recorded by the EK80 through a push button (11) and flag potential errors in the settings of the echosounder.

6 WP5: project management

6.1 Introduction

Several meetings were organised to discuss the expectations and concerns of the skippers, the RVZ and the scientific team in addition to several informal meetings among scientific team. Software installation was implemented for the first time on one of the commercial fishing boats. Furthermore the concept and the progress of the project was presented at a prestigious acoustics conference and valuable feedback was gathered.

6.2 Meetings

- Several project meetings between WMR and TNO to discuss project development.
- Meeting (WMR, TNO, RVZ, Jaczon, W. van der Zwan) at Jaczon on 17/02/2017:
  - provide an update on the project
  - show current software version and gather feedback (see WP 4)
- Meeting (WMR, TNO, RVZ, Jaczon, W. van der Zwan) at Jaczon on 09/06/2017:
  - provide an update on the project
  - discuss issues with data collection (see WP 2).

6.3 Miscellaneous

- Quarterly progress reports submitted regularly by TNO to WMR (TNO, see Annex 1 for an example)
- Regular email/phone contacts between WMR & TNO.
- The following publication will be presented at the Acoustical Society of America conference in Boston on 25-29 June (TNO):

  "*Classification of pelagic fish using wideband echosounders*"; authors: J.J.M. v.d. Sande, B.A.J. Quesson (TNO). The presentation will be given by Jeroen van de Sande.
- Sascha Fassler (project manager) left WMR in February 2017 resulting in a change in project management within WMR. Newly recruited acoustic scientists Benoit Berges and Serdar Sakinan took over the technical work while Edwin van Helmond is now in charge of the project management.

7 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

Furthermore, the chemical laboratory at IJmuiden has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2021 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation. The chemical laboratory at IJmuiden has thus demonstrated its ability to provide valid results according a technically competent manner and to work according to the ISO 17025 standard. The scope (L097) of de accredited analytical methods can be found at the website of the Council for Accreditation (www.rva.nl).

On the basis of this accreditation, the quality characteristic Q is awarded to the results of those components which are incorporated in the scope, provided they comply with all quality requirements. The quality characteristic Q is stated in the tables with the results. If, the quality characteristic Q is not mentioned, the reason why is explained.

The quality of the test methods is ensured in various ways. The accuracy of the analysis is regularly assessed by participation in inter-laboratory performance studies including those organized by QUASIMEME. If no inter-laboratory study is available, a second-level control is performed. In addition, a first-level control is performed for each series of measurements.
In addition to the line controls the following general quality controls are carried out:
Blank research.
Recovery.
Internal standard
Injection standard.
Sensitivity.

The above controls are described in Wageningen Marine Research working instruction ISW 2.10.2.105. If desired, information regarding the performance characteristics of the analytical methods is available at the chemical laboratory at IJmuiden.

If the quality cannot be guaranteed, appropriate measures are taken.

8 References

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MacLennan, D. (1981). The Theory of Solid Spheres as Sonar Calibration Targets. *Scottish Fisheries Research Report*, (22).

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Urick, R. J. (1996). *Principles of Underwater Sound 3rd Edition*. Peninsula Pub.

9 Justification

Report : 17006
Project Number: 4311400004

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Harriet van Overzee
Researcher

Signature:

Date: 10th of November 2017

Approved: Drs. J. Asjes
MT member Integration

Signature:

Date: 10th of November 2017

Annex 1: PROGRESS REPORT FROM TNO FOR Q3 (JANUARY-MARCH 2017)

TNO innovation for life

Memorandum ONGERUBRICEERD

Technical Sciences
Oude Waalsdorperweg 63
2597 AK Den Haag
P.O. Box 96864
2509 JG The Hague
The Netherlands

www.tno.nl

T +31 88 866 10 00
F +31 70 328 09 61

To
WMR / Edwin van Helmond

From
A.W.P. van Heijningen

Copy to
TNO / Benoit Quesson

Date
1 Mei 2017

Subject
ECHO-2 Quarterly Progress Report TNO Jan-Mar 2017

Our reference
060.19207-QPR2017Q1

Direct dialling
+31 88 866 40 41

Quarterly Progress Report 2017 January – March

Project reference:

a) TNO quotation "ECHO-2" to IMARES Wageningen UR of 17 December 2015 (TNO reference TNO-OFF-DTM-0100292604)
b) Appointments to TNO Quotation "ECHO-2" as described in the TNO letter to IMARES Wageningen UR of 5 August 2016
c) Project proposal IMARES "Practical implementation of real-time fish classification from acoustic broadband echosounder data" (RealFishEcho) of 3 June 2016, tender document 16.43.044
d) Overeenkomst van onder-opdracht met WUR-nummer 982269 d.d. 16 augustus 2016 ten behoeve van de werkzaamheden voor het project "Practical implementation of real-time fish classification from acoustic broadband echosounder data (RealFishEcho)"

This quarterly progress report (2017 January – March) reports the activities performed by TNO in scope of the above referenced project "ECHO-2" in this quarter. This reporting quarter corresponds to the 3rd project quarter.

An overview per WP of the performed activities in this reporting quarter, and of the foreseen next steps in the coming reporting quarter, is given below.

WP1 (calibration)

Done

- The EK80 calibration of the Afrika is in progress.
  Analyzing deviations from expected values together with WMR.
- Read in of calibration files and incorporation in the processing.

ONGERUBRICEERD

Next steps

- Proceed EK80 calibration issue with WMR.

Specific Points of Attention / actions

- n/a

WP2 (data collection)

Done

- Delivery to TNO of catch data from the SCH6 and SCH24 (up to Augustus 2016).

Next steps

- Delivery of catch data from the SCH6 and SCH24 to TNO when available.
- Collection of raw data on the SCH24 when the demonstrator

Specific Points of Attention / actions

- Delivery of associated ground truth at school level (in the new database format) to TNO.
- If more data available, it should be delivered to TNO as well (in the new database format)

WP3 (data analysis)

Done

- Data base format definition including ground truth (by WMR)

Next steps

- Database delivery to TNO
- Based on database, provide a geographical map of the catches

Specific Points of Attention / actions

- Delivery of associated ground truth at school level (in the new database format) to TNO necessary for full analysis and classification tests.

WP4 (SW development)

Done

- The first GUI version has been implemented based on end user requirements and has been demonstrated to the industry (through offline replay) in a meeting at Jaczon Bv on 17/02/2017.
- Interfacing question list sent to SCH24.

Next steps

- Possible GUI optimizations have been discussed and this feedback will result in an improved GUI in the final demonstrator version.
- Share GUI executable code with pre-processing and detection chain in Echo repository
- Write user documentation
- Write/update system documentation.

Specific Points of Attention / actions

- PoA: Appointment for the installation of the demonstrator with SCH24
- PoA: Interfacing cannot be fully tested prior to installation
- PoA: planning for the gathering of boar fish data (action WMR)

WP5 (Project management)

Done

- Technical meeting TNO/WMR on 01/02/2017 @TNO to discuss the processing
- Regular telephonic / email contacts

Next steps

- Invite new WMR PL (Edwin van Helmond) @ TNO

Specific Points of Attention / actions

- n/a

Other

Conference presentations / papers:

- ASA conference:
  An abstract has been accepted for presentation on the ASA conference of 25-29 June 2017, in Boston, with the title: "*Classification of pelagic fish using wideband echosounders*"; authors: J.J.M. v.d. Sande, B.A.J. Quesson (TNO). The presentation will be given by Jeroen van de Sande.

Previous progress reports:

- Combined ECHO-2 Q3-Q4 2016 progress report (project Q1 & Q2) – email of Benoit Quesson on 15-2-2017.

Wageningen Marine Research
T +31 (0)317 48 09 00
E: marine-research@wur.nl
www.wur.eu/marine-research

Visitors' address
- Ankerpark 27 1781 AG Den Helder
- Korringaweg 7, 4401 NT Yerseke
- Haringkade 1, 1976 CP IJmuiden

Wageningen Marine Research is the Netherlands research institute established to provide the scientific support that is essential for developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

Wageningen University & Research:
is specialised in the domain of healthy food and living environment.

The Wageningen Marine Research vision
'To explore the potential of marine nature to improve the quality of life'

The Wageningen Marine Research mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

Wageningen Marine Research is part of the international knowledge organisation Wageningen UR (University & Research centre). Within Wageningen UR, nine specialised research institutes of the Stichting Wageningen Research Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment.