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Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Marine Institute
Foras na Mara

CHERISH
Newid Hinsawdd a Threftadaeth yr Afordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

Report of Survey

Geological Survey Ireland
Anglesey, Wales 2018

INFOMAR
Integrated Mapping for the Sustainable Development of Ireland's Marine Resource

Geological Survey Ireland, founded in 1845, is the national earth science agency. It is responsible for providing geological advice and information and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geology. GSI is a division of the Department of Communications, Climate Action & Environment (DCCAE).

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CHERISH Project

CHERISH (Climate, Heritage and Environments of Reefs, Islands and Headlands) is a 5 year (2017-2021) European-funded Ireland-Wales project between the Royal Commission on the Ancient and Historical Monuments of Wales, the Discovery Programme: Centre for Archaeology and Innovation Ireland, Aberystwyth University: Department of Geography and Earth Sciences and Geological Survey Ireland. The project will receive €4.1 million through the Ireland-Wales 2014-2020 Interreg Programme.

CHERISH is a cross-disciplinary project. It aims to raise awareness and understanding of the past, present and near future impacts of climate change, storminess and extreme weather events on the rich cultural heritage of the Irish and Welsh regional seas and coast. It employs innovative techniques to study some of the most iconic coastal locations in Ireland and Wales.
www.cherishproject.eu

Disclaimer

The data presented in this report, particularly hydrographic data, is acquired as part of a baseline study and should not be used for navigational purposes.

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General Area	**Menai Straits, Anglesey, Wales**
Name of Survey	**CHERISH: Wales Marine Survey 2018**
Area/Block number	**N/A**
Unit Names	R.V. Keary (KRY)
Survey Leg Reference Numbers	KRY18_03
Company	**INFOMAR (Geological Survey of Ireland)**
Charge Surveyor	**Sean Cullen**
Start Date of Survey	**8th August 2018**
End Date of Survey	**22nd August 2018**
Recommended survey category	**N/A**
Report version	**Final**

Glossary

INFOMAR:	Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
GSI:	Geological Survey of Ireland
IHO:	International Hydrographic Organisation
JNCC:	Joint Nature Conservation Committee
UKHO:	United Kingdom Hydrographic Office
DCCAE:	Dept of Communications Climate Action & Environment
STCW95:	Standards of Training Certification and Watch-keeping
MBES:	Multibeam Echosounder
SBES:	Singlebeam Echosounder
SBP:	Sub-bottom Profiler
SSS:	Sidescan Sonar
H-NOTE:	Hydrographic Note
HI:	Hydrographic Instruction
TPU:	Total Propagated Uncertainty
LAT:	Lowest Astronomical Tide
GNSS:	Global Navigation Satellite System
VORF:	Vertical Offshore Reference Frame
PPE:	Personal Protective Equipment
MMO:	Marine Mammal Observer
QC&QA	Quality Control & Quality Assurance

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Executive Summary

Survey Summary			
Survey Vessels:	R.V. Keary (GSI)	Survey Legs:	KRY18_03
Mobilisation Port:	Dun Laoghaire, Co. Dublin	Demobilisation Port:	Dun Laoghaire, Co. Dublin
Survey Area/s:	Anglesey, Wales	Survey Duration:	08/08/2018 – 22/08/2018
N Boundary: S Boundary: E Boundary: W Boundary:	53.40614° N 53.08410° N 03.96991° W 04.45788° W	} WGS1984	
UKHO Admiralty Charts	1970 and 1977		
Key References			

Survey Statistics			
Minimum Water Depth (LAT):	4.2m above LAT	Maximum Water Depth (LAT):	31.1m below LAT
Area Covered (Km^2):	14.00	Survey Line Kilometres:	391.81
Operational (based on 24h days):	KRY – 3d 20h	Downtime (based on 24h days):	KRY – 2d 08h
Groundtruthing Stations:	0	Incidents to Report	0

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1 Introduction

This Report of Survey document represents survey work carried out by Geological Survey of Ireland INFOMAR vessel RV Keary in CHERISH areas off the Isle of Anglesey, Wales in 2018. Authorisation for the survey was received from the Maritime Policy Unit of the Foreign & Commonwealth Office (Ref 83/2018 – Annex 1). There was no requirement for a marine licence for the activities conducted (multibeam geophysical surveys) as outlined by the Marine Management Organisation guidance.

This document is intended to provide a thorough overview of survey specifications, standards and quality control measures implemented during survey operations. It provides a record of the datasets acquired during operations and a description of how this data was modified (processed) and managed before leaving the vessel for final validation and distribution to the end user.

The CHERISH project identified a number of sites around Anglesey for which the project required detailed bathymetric surveys. Two main type of sites were targeted; islands and shipwrecks. Islands that were identified for survey were Dulas and Puffin in the north east of Anglesey and Skerries on the north west. The objectives of targeting these islands were to both further understand their evolution and to join bathymetric data with existing LIDAR data for analyses. A number of shipwrecks were also targeted. These shipwrecks were located in proximity to the islands and also at the south west entrance of the Menai Strait.

Multibeam surveying was to be carried out in depths <50m using the Geological Survey research vessel Keary which is equipped with a Kongsberg EM 2040 D multibeam echosounder between the 8th and 23rd of August 2018. Sub-bottom profiling using an Edgetech CHIRP 3200 was conducted along all survey lines.

While survey results are presented in the final section of this document, it is designed to be used in conjunction with a standard set of additional reports which are included within as annexes. Accordingly, when taken together with this Report of Survey document, the annexes form the overall CHERISH Anglesey, Wales 2018 survey report.

2 Survey Overview and Activity

2.1 Project Overview

The purpose of this survey was to create an integrated bathymetric and geophysical dataset for CHERISH areas off the Isle of Anglesey, using a range of platforms and sonar equipment. Bathymetry was to be acquired to IHO S-44 Order 1a Standard. One GSI vessels was mobilised for the survey by the Geological Survey of Ireland (R.V. Keary).

2.2 Survey Area

The distribution of survey effort by R.V. Keary is shown in Figure 1 below

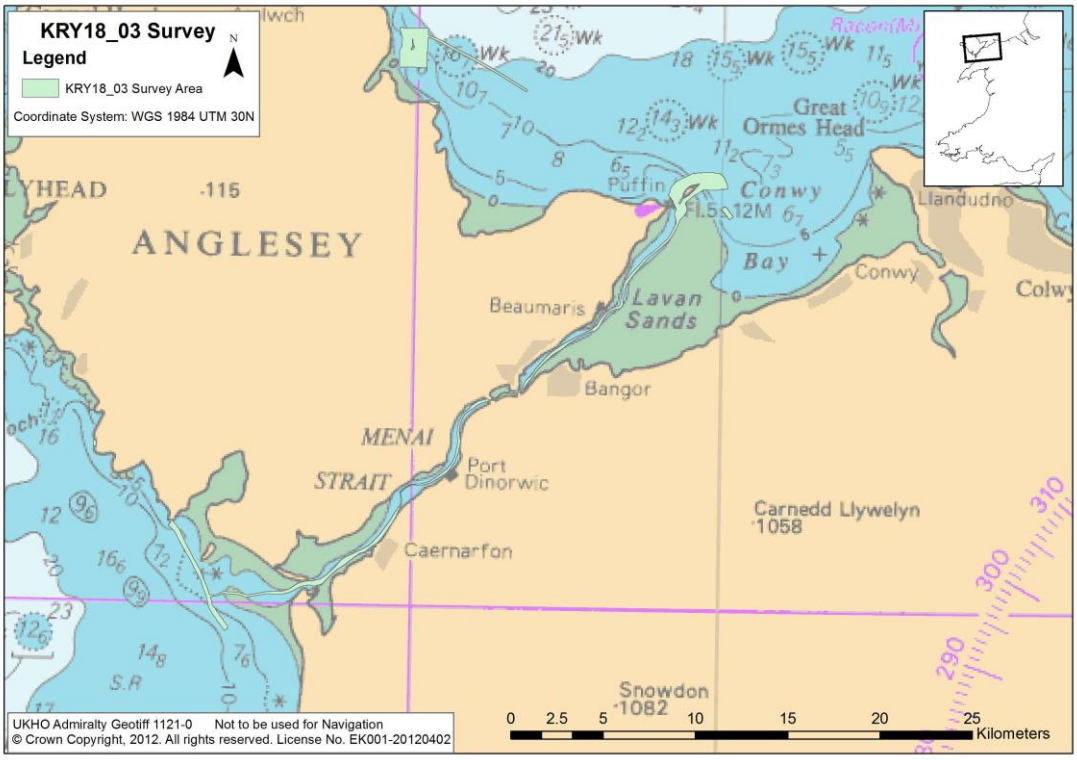


Figure 1: Survey Coverage Polygons of RV Keary during KRY18_03.

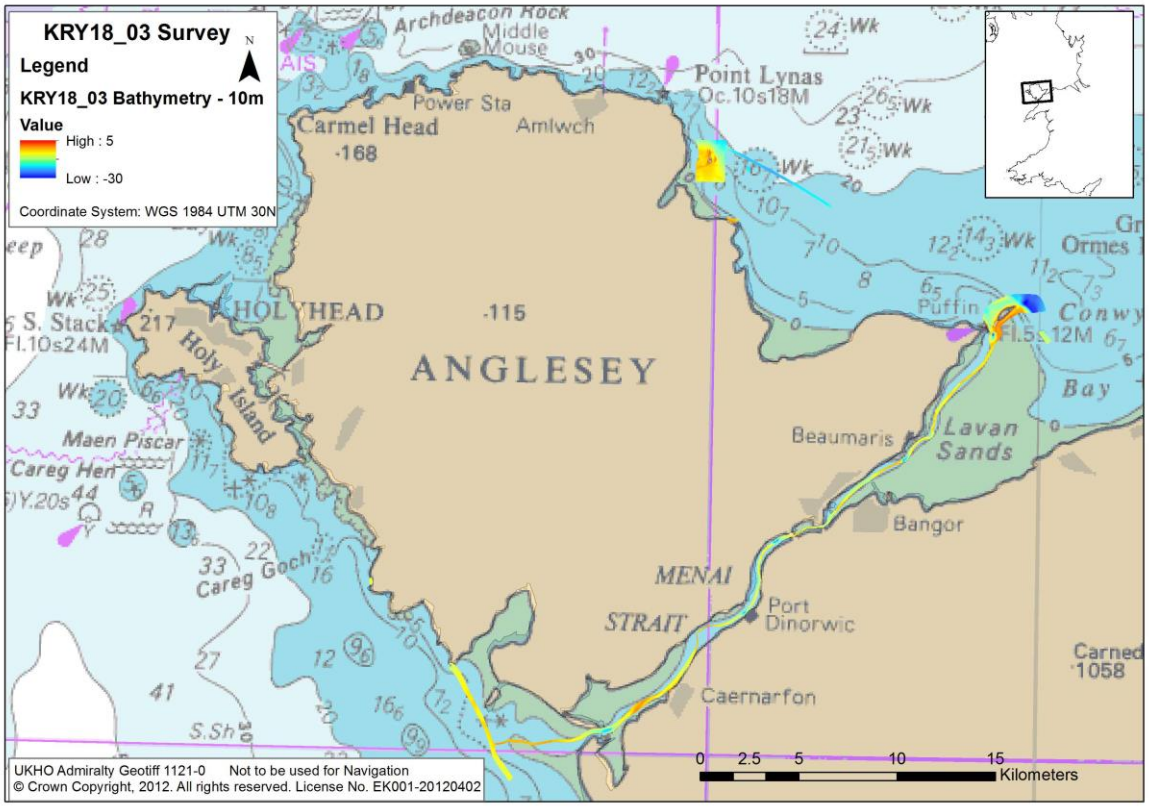


Figure 2: Overall Bathymetry – Surveyed Area (Depths reduced to LAT)

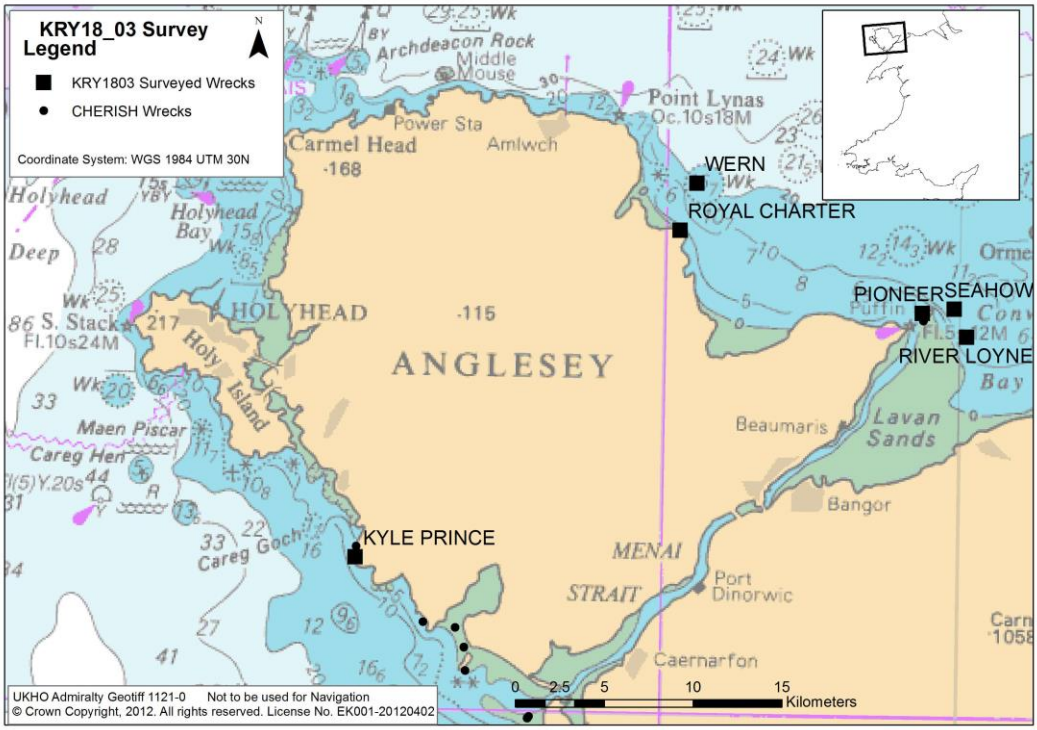


Figure 3: Assessed wrecks (circles) and surveyed wrecks (squares) within surveyed area

2.3 Survey Team

2018 CHERISH survey operations off Anglesea were crewed by a team comprised of contractors staff from the GSI. Table 1 table below lists all personnel involved with these survey operations.

Crew Member	Capacity	Organisation
Agust Magnusson	Skipper	Contractor
Padraig Cronin	Data Processor/Surveyor	GSI-Contract
James Barry	Party Chief / Data Processor	GSI-Contract

Table 1: Survey Team

2.4 Survey Statistics

Operations tables for each survey leg are provided along with an over-arching summary of activity carried out during the 2018 CHERISH Anglesea survey. Should an individual day by day breakdown be required, this information is contained in the digital DPR (Daily Progress Report) issued each day and available as part of the final project data delivery.

Table 2 provides a breakdown of how daily events are categorised for reporting purposes. For INFOMAR survey operations, the inshore survey vessels operate a 12 hour working day with 12 hours scheduled every 24 hours, for an overnight port-call.

Event Descriptor	Events Covered
Port Call	Vessel alongside, usually for night hours, PR events and mobilisation/demobilisation.
Standby	Survey staff are working but vessel is not acquiring survey data
Downtime Vessel	Operations ceased due to problem with vessel systems
Downtime Survey	Operations ceased due to problem with survey systems
Data Acquisition	Vessel is acquiring data and or validation data
Weather Standby	Operations ceased due to poor weather
Ground-truthing	Seabed sampling, video/stills imagery ground-truthing
Transit	Vessel is operational and travelling to destination
Other	non-standard work within the scope of normal operations

Table 2: Event Descriptor Breakdown

	Stats: Hours	Stats: Days	Stats: Percentages
Port Call	176.64	7.36	49.10
Weather Standby	29.28	1.22	8.15
Extra Work	0.00	0.00	0.00
Standby	26.40	1.10	7.31
Transit	35.04	1.46	9.75
Operational	55.44	2.31	15.39
Other	36.24	1.51	10.09
Downtime Survey	0.00	0.00	0.00
Downtime Vessel	0.72	0.03	0.21
Calibrations	0.00	0.00	0..00

	Stats: Total Hours	Stats: Total Days	Stats: Total Percentage
	359.76	15.00	100

Table 3: KRY18_03 Operations Summary

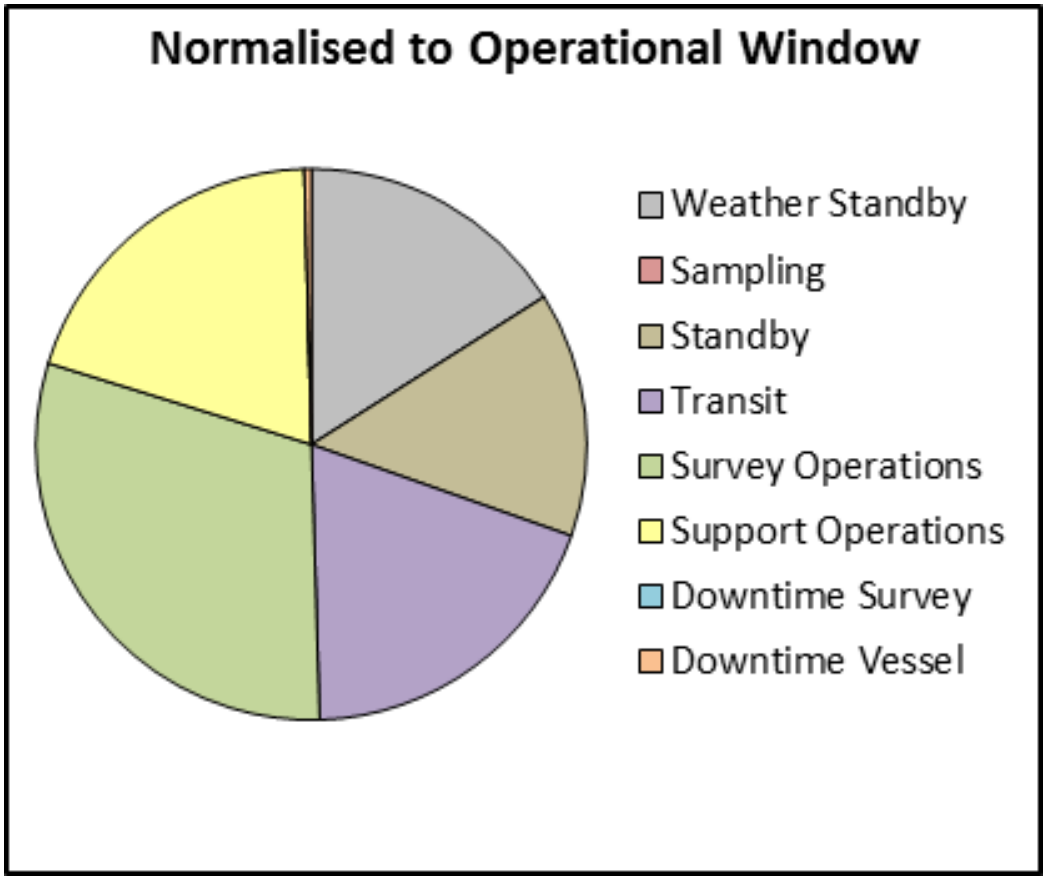


Figure 4: KRY18_03 Survey Statistics Pie Chart

Survey Leg	Line Kilometres (km)	Area Covered (km^2)
KRY18_03	457.34	14.00

Table 4: CHERISH Anglesey, Wales 2018 Operational Statistics

2.5 Health, Safety, Environment (HSE) and Licensing / Permissions

Responsibility for all personnel and equipment in relation to damage, loss or injury incurred in the mapping of CHERISH Anglesey, Wales areas in 2018 was assumed by the GSI. GSI Hydrographer, Sean Cullen assumed the role of "Charge Surveyor" for the overall project, with all policies put into practice by senior surveyors/party-chiefs during each leg of survey operations.

The GSI operated a Safety Management Plan for all vessels during the course of the 2018 CHERISH Anglesey, Wales survey. A "no drugs or alcohol" policy was in place for all survey operations on all platforms throughout.
Daily meetings were conducted as often as possible during the 2018 CHERISH Anglesey, Wales survey on the aft deck of the R.V. Keary each morning.
Due to the shallow-water environment being surveyed as part of this project, responsibility for safe navigation rested solely with the Master/Skipper of each individual vessel all of whom were familiar with shallow water surveying techniques.
All offshore personnel working on the project required valid ENG11 Medical certification, STCW95 sea-survival and other relevant certification as required by their role.
Safety induction and familiarisation exercises were carried out on all survey platforms prior to the commencement of the survey leg. Safety drills were conducted periodically and logged in the vessel's log books.
To operate in CHERISH Anglesey, Wales areas, approval was granted by the UK Foreign and Commonwealth office on 31st July 2018 (NV 83/2018). All conditions outlined in that document were abided by including all applicable UK and EU laws.

2.6 Incidents

Incidents and Near-misses

The project partner's survey reporting policy provides a framework for the reporting of incidents and near-misses as they arise during operations.
During the course of the 2018 CHERISH Anglesey, Wales survey, no major incidents requiring reporting occurred.

Equipment Damage and Loss

During the course of the 2018 CHERISH Anglesey, Wales survey, no equipment was damaged or lost.

3 Survey Systems and Setup

3.1 Survey Platforms

The CHERISH project utilised one survey vessel, operated by GSI, in the implementation of survey work in CHERISH Anglesey, Wales in 2018 - R.V. Keary,.

3.1.1 R.V. Keary

The Irish state research vessel R.V. Keary is an aluminium catamaran designed for near shore survey work. She is ideally suited in this role due to her stable twin hull construction, shallow draft, retractable equipment pod and hydraulically operated A-Frame and winch. The R.V. Keary is typically crewed by a team of 3 individuals. Table 7 provides information on her design specifications and survey equipment on board.

Figure 5: R.V. Keary

Specification / System	Information
Length OA	15.5 m
Length (hull)	14.6 m

Beam (moulded)	5.6 m
Draught	1.9 m
Draught with pod deployed	2.4 m
Engines	2 x Cummins QSC 8.3 – 500 INT
Power output	368 kW/2600 RPM/Triple Phase
Transit Speed / Survey Speed	22 knots / 7.5 knots
Fuel	2000 lt Diesel
Generator	Cummins Onan 13.5 kva
Max passenger and crew	12 persons
Passenger Licence	P5
MBES	Kongsberg Simrad EM2040
SBES	Kongsberg Simrad EA400
Subbottom Profiler	Edgetec 3200XS Chirp
R/T SV	AML smart probe (pod mounted)
CTD/SVP	Valeport Mini SVP
Sparker	Geo-Resources Geo-Spark 200
Positioning System and IMU	POS-MV 320
DGPS	Hemisphere RTCM DGPS
Sediment Samplers	Duncan & Associates Day and Hand grabs
USBL	Sonardyne Scout
SSS	Edgetec 4200

Table 5: R.V. Keary Vessel Specifications

3.1.2 Survey Software Utilised

The table below provides details on the primary software tools utilised by INFOMAR survey vessels during the 2018 CHERISH Anglesey, Wales. Further information is provided in section 3 of this document under Survey Data Summary.

Survey Aspect	Vessel	Software
MBES Data Acquisition	R.V. Keary	Kongsberg SIS
Online Survey Planning	R.V. Keary	QINSy
Online Navigation	R.V. Keary	MV-POSVIEW
SBES Data Acquisition	R.V. Keary	Simrad EA400
Shallow Seismic Data Acquisition	R.V. Keary	Edgetec Discovery
Data Processing	R.V. Keary	POS-PAC & CARIS
Survey Reporting and Statistics	R.V. Keary	Multilog
GNSS Base Station Data	R.V. Keary	Leica Geo-Office
SVP Data Acquisition	R.V. Keary	Datalog Express

Table 6: Software Utilised

3.2 Geodetic Parameters

Local Datum Geodetic Parameters	
Datum	ETRS89
Spheroid	World Geodetic System 1984 (WGS-84)
Semi-Major Axis (a)	6378137.000 m
Semi-Minor Axis (b)	6356752.314 m
First Eccentricity Squared (e^2)	0.0066943800
Inverse Flattening (1/f)	298.257223563
Projection Parameters	
Grid Projection	Universal Transverse Mercator
Central Meridian Zone 30 (CM)	003° West
Origin Latitude (False Lat.)	00.0°
Hemisphere	North
False Easting (FE)	500000.0 m
False Northing (FN)	0.0 m
Scale Factor on CM	0.999600
Units	Metres

Table 7: Survey Geodetic Parameters

3.3 Vessel Dimension Control

Vessel and equipment offsets and sensor mounting angles utilised during the course of the 2018 survey season were determined for each survey vessel through a dimension control survey. Dimension control reports and documentation are available from GSI project management on request.

It is important to note that the application of offset / installation angle / correction values were applied to raw survey data using a variety of methods, specific to each vessel's individual setup, often using a combination of software programs in order to achieve the best results for the application of position and motion corrections to sounding data. A full discussion of these processes falls outside the scope of this document, however further information can be provided by GSI on request.

The tables presented in the subsections below give details of the various offsets as they were input to the main survey systems (i.e. offset and angular values according to the software programs with which they were applied). For clarity; installation diagrams are provided demonstrate the combined effects of these values on the survey system set-up.

Where fractional adjustments of the values presented in this section were deemed necessary through patch-test and calibration work and during final data processing, these values were modified in the CARIS HIPS & SIPS vessel file and are as a result, recorded in this file which is part of the final data delivery.

3.3.1 R.V. Keary

Installation offsets and angles for the R.V. Keary's primary survey hardware were re-determined through dimension control survey. These values were applied to survey systems using Kongsberg SIS and Applanix MV-POS-View software.
Values derived from the original dimension control survey were verified through standard calibration tests and refined where necessary.

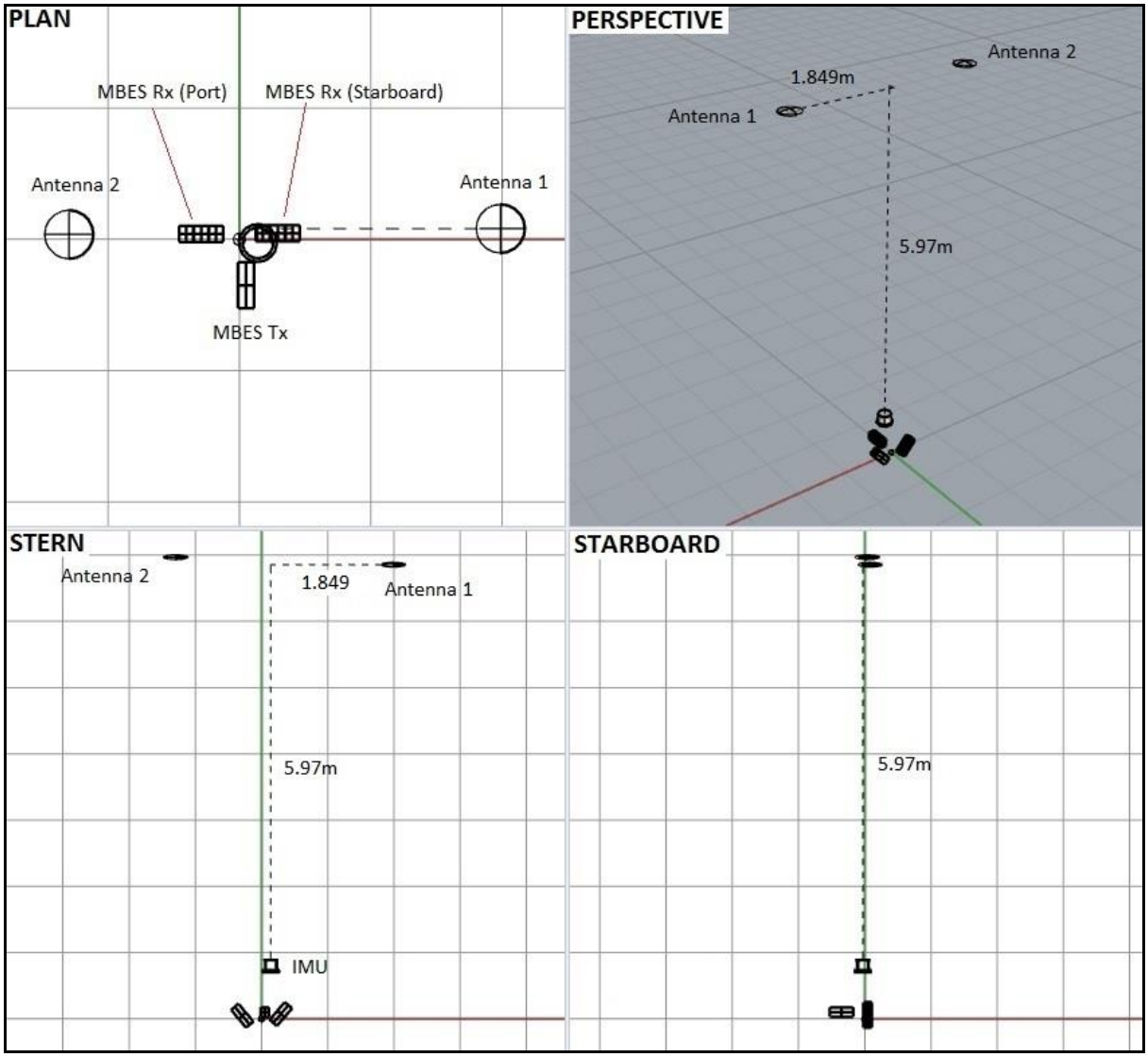


Figure 6: R.V. Keary MBES System Installation Offsets - Overview

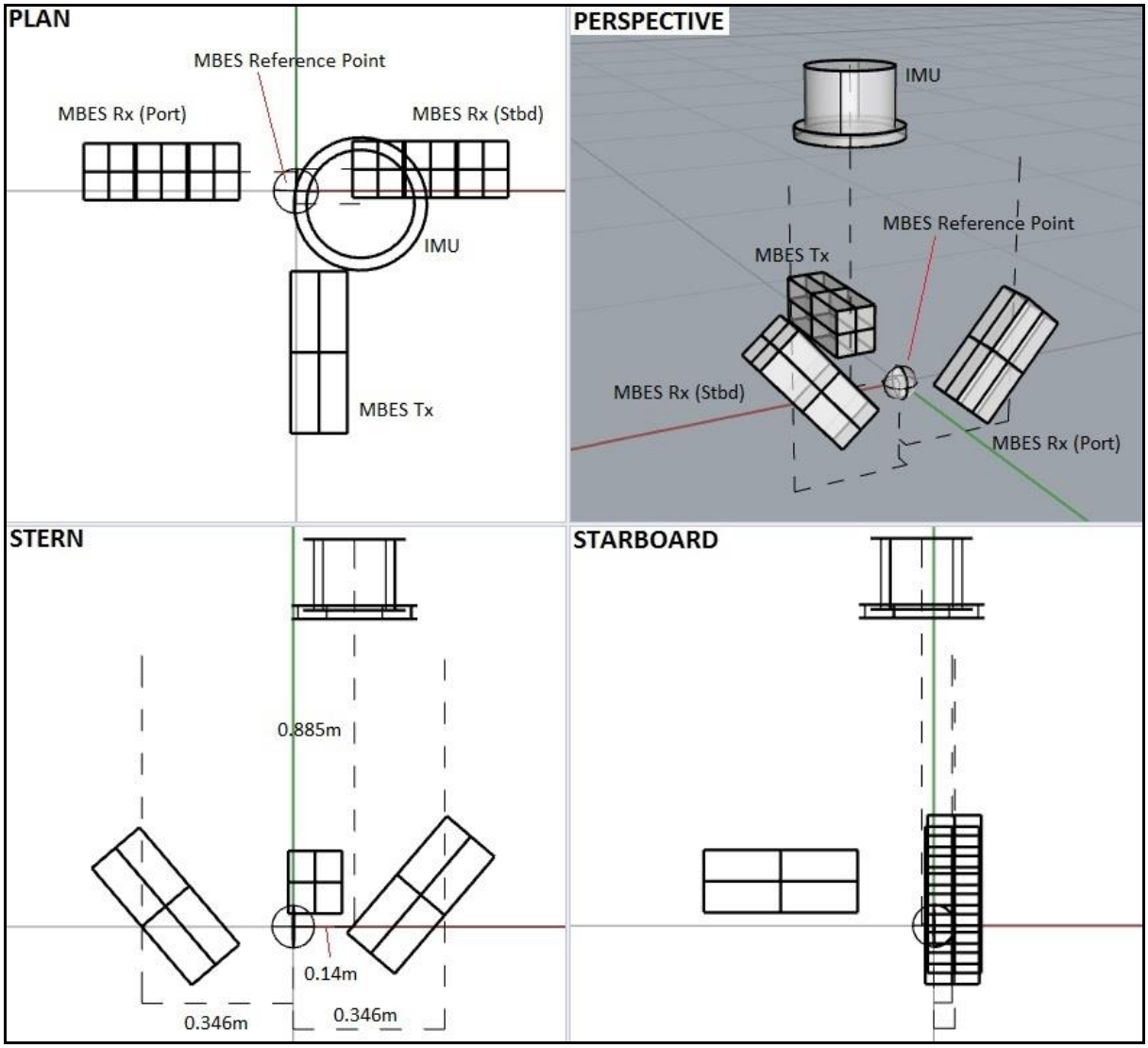


Figure 7: R.V. Keary MBES System Installation Offsets – Sensor Detail

R.V. Keary Offsets (metres)	X (Stbd +)	Y (Bow +)	Z (Up +)
MBES Reference Point	0	0	0
EM2040 MBES Sonar Head 1 (Port)	-0.346 m	0.042 m	0
EM2040 MBES Sonar Head 2 (Stbd)	0.346 m	0.047 m	0.026 m
POS-MV IMU relative to ref. point	0.14 m	-0.028 m	0.885 m
Waterline Value (0,0,0)	0.880 m		
Installation Angles (degrees)	Roll	Pitch	Heading
EM2040 MBES Sonar Head 1 (Port)	41.82°	0.875°	0.977°
EM2040 MBES Sonar Head 2 (Stbd)	-37.899°	1.467°	358.116°
POS-MV IMU	0	0	0

Table 8: R.V. Keary Installation Parameters Applied in SIS

R.V. Keary Applanix POS-MV Software (IMU as Origin)			
Heave & Sensor 1 & 2 Install Params.	Roll	Pitch	Heading
Sensor 1 alignment angles in degrees	0	0	0
Sensor 2 alignment angles in degrees	0	0	0
	X (Bow +)	Y (+ Stbd)	Z (+ Down)
Sensor 1 lever arm in meters	0.14	-0.028	0.885
Sensor 2 lever arm in meters	0	0	0
Centre of Rotation in meters	0	0	0
GAMS Install Parameters			
Ant 1 – Ant 2 antenna separation (m)	3.289		
Ant 1 – Ant 2 baseline vector (m)	-0.044	-3.287	-0.114
Heading error for calibration	0.35		
Ant 1 – Ant 2 azimuth correction	0		
	Roll	Pitch	Heading
Vehicle to reference alignment angles	0	0	0
Reference to IMU alignment angles	0	0	0
	X (Bow +)	Y (+ Stbd)	Z (+ Down)
Reference to IMU lever arm (m)	-0.020	-0.006	0.102
Reference to primary GNSS lever arm (m)	0.109	1.849	-5.970

Table 9: R.V. Keary Installation Parameters Applied in POS-MV

3.4 Calibration and Validation Work

Survey platforms undertook individual calibration exercises and validation checks prior to the commencement of the survey season. Further information relating to this work can be found in Section 6 of this document and full details are available from GSI management on request.

3.5 Survey Order and Objectives

Survey work was carried out to International Hydrographic Organisation (IHO) Special Publication (S-44) Order 1a. The objective for the survey was to acquire high resolution MBES bathymetry and backscatter data within the designated survey areas.

3.6 Survey Datum, GNSS Tides and VORF Model

All depth soundings delivered by GSI survey vessels were reduced to LAT using the UKHO's VORF model. The model provides a separation value between the WGS84 Ellipsoid and LAT..

Figure 8 provides a basic illustration of the reduction of soundings data using the UKHO VORF model value for LAT.

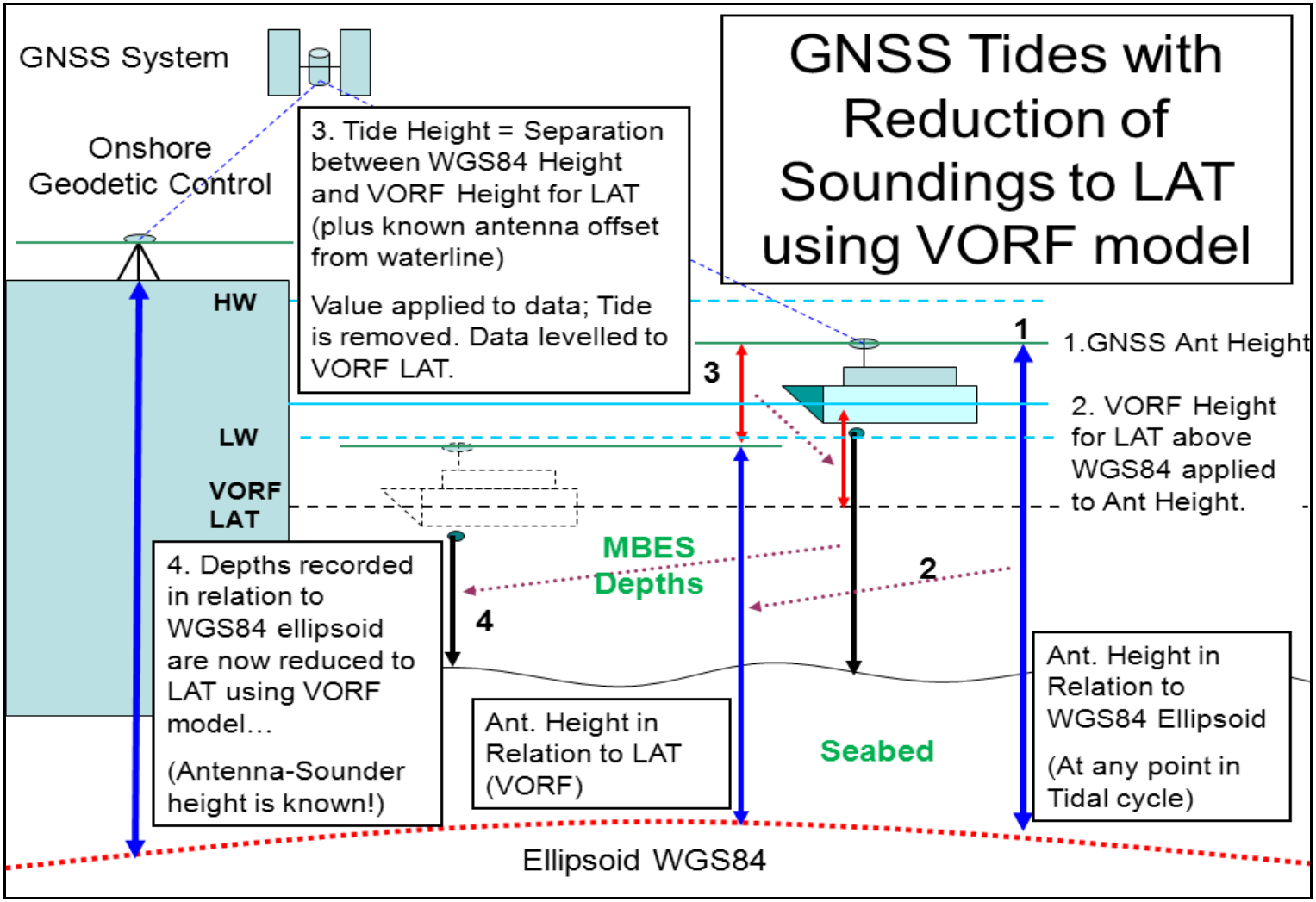


Figure 8: VORF-GNSS Reduction of Soundings

4 Survey Data Summary (Data Rendered)

Survey data acquisition conducted by GSI in the mapping of CHERISH Anglesey, Wales in 2018 was carried out by R.V Keary. Details on survey activity and vessel set up are provided in sections 1 and 2 of this document. This section provides information on data rendered by the GSI vessels.

4.1 MBES Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY18_03
MBES System	Kongsberg Simrad EM2040
Survey Lines (including crosslines)	268
Data Files	269 (including test lines)
Date Created	08/08/2018 – 22/08/2018
Dataset size	81 GB
File format	.ALL

Table 10: MBES Data logged during CHERISH Anglesey, Wales Survey 2018

4.2 SBES Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY18_03
SBES	Simrad EA400
Survey Mainlines	259
Data Files	259
Date Created	09/08/2018 – 22/08/2018
Dataset size	12.6 GB
File format	.jsf, .dg, .out, .xyz

Table 11: SBES Data logged during CHERISH Anglesey, Wales Survey 2018

4.3 Shallow Seismic Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg & Year	KRY18_03
Chirp	Edgetec 3200XS
Survey Mainlines	259
Data Files	259

Date Created	09/08/2018 – 22/08/2018
Dataset size	5.64 GB
File format	.JSF

Table 12: Shallow Seismic Data logged during CHERISH Anglesey, Wales Survey 2018

4.4 Navigation Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY18_03
Navigation System	POS-MV
Data Files	357 (excluding USB backup)
Date Created	08/08/2018 – 22/08/2018
Dataset size	6.32 GB
File format	.000/.001 etc. POS MV format

Table 13: Navigation Data logged during CHERISH Anglesey, Wales Survey 2018

4.5 Water Column, Sound Velocity and Oceanographic Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY18_03
Instrument	Valeport Mini SVP (Bluetooth)
Sound Velocity Data Files	9 CARIS Daily Files (each day's casts combined into one file)
Dataset size	164 KB (CARIS format)
Date Created	09/08/2018 – 23/08/2018
File formats	CARIS .svp

Table 14: Sound Velocity Data logged during CHERISH Anglesey, Wales Survey 2018

4.6 Backscatter Data

Descriptor	Metadata
Backscatter	GeoTIFFS
Data Files	1m, 2m, 5m & 10m Grids
Dataset size	45.4 MB

Table 15: Backscatter Data logged during CHERISH Anglesey, Wales Survey 2018

4.7 QINSy Online Navigation Data

Descriptor	Metadata
Vessel	R.V. Keary
Survey leg	KRY18_03
Dataset size	29.5 MB
Data Files	367

Table 16: QINSy Project Data logged during CHERISH Anglesey, Wales Survey 2018

4.8 Final Data Delivery

The table below details the total amount of data generated by R.V. Keary during CHERISH Anglesey, Wales survey 2018.

Survey Leg	Dataset Size
KRY18_03	693 GBB, 19693 files

Table 17: Final Data Delivery from CHERISH Anglesey, Wales Survey 2018

5 Data Processing

5.1 Data Processing

During survey operations all datasets were subject to first pass data processing in the field in close to real-time by on board data processors. This work was carried out by the personnel listed in Section 1.3 of this document, in order to ensure the required standards were obtained.
Finalisation of all MBES datasets (1 survey leg) which encompasses the overall 2018 CHERISH Anglesey, Wales survey delivery, was carried out prior to delivery of all data to UKHO. An overview of the data processing methodology employed is discussed below.

5.2 Navigation Processing

GSI operated vessels are equipped with Applanix POS-MV sensors which provide an integrated solution for positioning and motion reference information. Raw data from these systems are logged in Applanix propriety format and processed using Applanix POS-PAC software.
This data is processed by uploading the GNSS data to PPRTX for processing. The processed data is natively in ITRF14 and subsequently transformed to ETRS89, using Applanix Pospac before merging with MBES data.

5.3 MBES Data Processing Methodology

All Raw MBES data files acquired during the project were converted and imported into CARIS HIPS & SIPS software. Once converted, survey datasets were then organised specific Julian day. The following workflow commenced.

Data →Qimera→ Processing→GSF→CARIS→Cleaning→Products

5.3.1 Sounding Data Processing Workflow

Data gets imported into Qimera and the following cleaning steps occur:

- True Heave was derived from raw POS-MV logged data and applied to survey data.
- Reprocessed navigation data from POS-PAC was applied to survey data.
- Navigation error data was calculated from POS-PAC processing and applied to survey data in CARIS HIPS & SIPS.
- SVP (Sound Velocity Profile) Data was then applied to correct for refraction errors caused by water column heterogeneity. A range of SV Algorithms were used to determine the most suitable method of applying SV corrections. (Example: nearest in distance verses nearest in time).
- GNSS tides were computed and soundings reduced to LAT (Lowest Astronomical Tide) using the UKHO's VORF model. GNSS Tide Results were then checked for quality and consistency.

At this point the day's survey data was merged in CARIS and TPU (Total Propagated Uncertainty) values were calculated.
Data cleaning was carried out using a range of tools in CARIS HIPS & SIPS to clean "noise" from the data. A CARIS base surface was then created to guide subset editing.
A depth surface was produced during subset editing with erroneous depths removed.

5.3.2 Backscatter Mosaic Generation

Raw multibeam data was imported to QPS FMGT and processed using the geocoder algorithm.

6 Quality Control and Quality Assurance

6.1 QA and QC Procedures Overview

Data Quality Assurance (QA) was maintained during survey operations using a combination of techniques including vessel handling and online acquisition quality checks to ensure data acquisition is conducted to the required standard.

Post-data acquisition Quality Control (QC) checks were made during first pass data processing and more rigorously during final data processing. Quality Control processes and procedures employed during this survey are described in this section.

6.2 Operational and Online QA Procedures

1. During survey operations, MBES data quality was maintained by setting outer beam angles of not greater than 68 degrees for each transducer head (in certain cases the angles are increased for greater coverage, e.g. for vessel safety in hazardous areas).
2. Close attention was paid to sea state and weather conditions. Survey grounds were examined for sheltered areas to suit changing conditions.
3. Good swath overlap and correct survey speeds ensured good data quality and safe operation of the vessel within shallow areas.
4. A strong focus on acquiring sufficient sound velocity profiles during each day's data acquisition allowed the on-board data processor to adequately correct sounding data for MBES refraction errors.
5. POS-MV navigation data was logged statically for a minimum of 20 minutes prior to departure, then continuously throughout the day and for 20 minutes after arrival to port on completion of each day's survey operations. (In the event of a POS-MV failure and system restart; data must be logged for 20 minutes before resuming survey operations).
6. In areas of poor GPS/GNSS satellite coverage GNSS mission planning was undertaken to avoid the worst affected periods. Cross lines are run to ensure good agreement of MBES data across the survey area and to generate cross-line statistics (Section 6.7) to demonstrate survey order achieved.
7. Data quality was monitored during acquisition by the vessel's online surveyor.
8. Close attention was paid to position accuracy thresholds during data acquisition.
9. Data was monitored online using the acquisition software listed in Table 6.
10. A series of alert displays were continuously monitored to ensure all data feeds and connections were active and functioning correctly throughout survey operations.

6.3 Post Data Acquisition QC Procedures

Navigation Data was checked for quality by the on-board data processor during first-pass QC processing.

Applanix POSPAC software was used to post-process the POS-MV data and resulting outputs were QC'd by evaluating plots of Altitude/Height, vertical RMS and satellite geometry.

MBES data was checked for quality using CARIS HIPS and SIPS software, in attitude editor and subset editor. Data density, survey statistics and error/uncertainty values were examined in this software to ensure IHO standards were maintained throughout. (S44-Order 1a)

Final data processing work (outlined in Section 5 of this document) carried out on these survey datasets resulted in the delivery of a depth surface that was QC'd and corrected for erroneous positions and depths. Statistical analysis (presented in Section 6.7of this document) was carried out on the dataset to demonstrate that the final product met all required specifications.

6.4 Survey Standard

The surveys reported on here were carried out to International Hydrographic Organization (IHO) Order 1a standard as per special publication S-44.

Table 18 describes the key requirements in order to meet these standards and represent the minimum standards for position and depth accuracy achieved during data acquisition.

Section 6.7 of this document presents the results of analysis carried out on survey cross-lines in order to determine the reliability/repeatability of depths obtained. The results provided demonstrate that the required IHO Order 1a standard was obtained for all survey legs during the INIS-Hydro project with greater than 95% confidence.

	Order 1a (S-44)	Special Order (S-44)
Description of Areas	Shallower than 100m, features of concern to shipping.	Areas where under-keel clearance is critical
Max THU allowable (95%C)	Total Horizontal Uncertainty (THU) 5m+5% of depth	Total Horizontal Uncertainty (THU) 2 metres
Max TVU allowable (95%C)	See Figure 22	See Figure 22
Full Seafloor Search	Required	Required
Feature Detection	Cubic Features > 2m (Depths < 40m) 10% depth > 40m	Cubic Features > 1m

Table 18: IHO Standards for Hydrographic Surveys

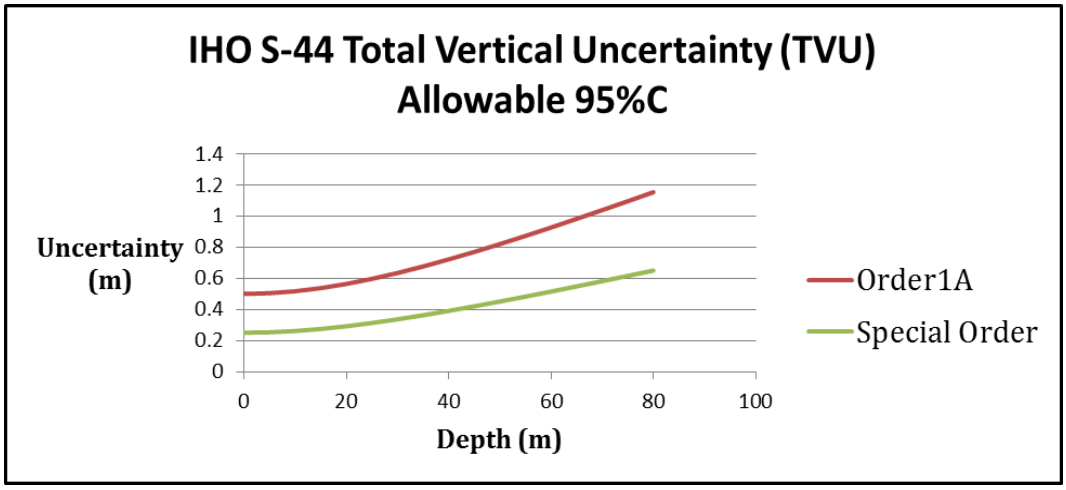


Figure 9: Maximum Allowable Total Vertical Uncertainty at 95% Confidence

6.5 CARIS Hips & Sips Total Propagated Uncertainty Models

Standard deviation values for offset, alignment and timing errors were applied to survey data as part of a Total Propagated Uncertainty (TPU) computation made in CARIS HIPS & SIPS software. This process allows TPU to be utilised during statistical data cleaning and surface generation as required.

The process in CARIS uses the same variables as described earlier. The main factor to note is the value applied for Sound Velocity Measurement Error (2.5 m/s). A further discussion on how environmental control was maintained over sound velocity conditions during survey operations is provided in Section 6.6.

Cross-Line Statistics presented in Section 6.7 which have been computed using levels of uncertainty listed in the subsections below have been demonstrated to be within IHO Order 1a standard at 95% confidence for all beam angles.

Propagator	Standard Deviation
Heave Error	3% of Heave Amplitude
Measurement Errors	0.01 m
Gyro Alignment Errors	0.1 deg
Pitch Alignment Errors	0.02 deg
Roll Alignment Errors	0.02 deg
Gyro Measurement Error	0.02 deg
Pitch Measurement Error	0.02 deg
Roll Measurement Error	0.02 deg
Navigation Measurement Error	0.1 m
Transducer Timing Error	0.001 s
Navigation Timing Error	0.001 s
Gyro Timing Error	0.001 s
Heave Timing Error	0.001 s
Pitch Timing Std Dev	0.001 s
Roll Timing Error	0.001 s

Sound Velocity Measurement Error	2.5 m/s
Surface Sound Velocity Measurement Error	0.1 m/s
Tide Measurement Error	0.1 m

Table 19: 2016 Standard Deviation values used in TPU calculation

6.6 Sound Velocity Regime and Environmental Control

To maintain control over the sound velocity regime in the survey area, frequent sound velocity profiles were acquired and generally survey lines were restricted to small geographic areas and survey blocks especially when closer to shore.

Target thresholds for sound velocity uncertainty in the order of 2m/s were deemed adequate for maintaining environmental control during survey operations. In areas of highly variable water column structure, this is not always possible.

6.7 Cross-line Statistics

Survey lines run perpendicular to the general trend of survey main-lines were acquired during the CHERISH Anglesey, Wales 2018 survey. Due care was taken to run cross-lines in optimum weather conditions. Sound velocity profiles were acquired at the beginning or end of each line to ensure good environmental control was maintained over the water-column.

Where necessary, further filtering of outer beam angles was undertaken during data processing. The resultant data was fully processed and used to generate a “true” depth surface.

A quality control examination of the mainline data using CARIS HIPS & SIPS software was undertaken by comparing survey mainlines against the “true” surface computed using cross-line data.

Analysis was conducted across the entire range of potential beam angles (up to 150 degrees) in sectors of 5 degrees for each survey leg.

Results demonstrate the order of survey achieved and are presented below, for each survey leg comprising the overall 2018 CHERISH Anglesey, Wales dataset. Vessel track-lines are illustrated in Results Section 8.1. This imagery illustrates the location of the cross-lines used for QC.

Beam Angle (deg)	Count	Max (+)	Min (-)	Mean	Std Dev	Special Order (%)	Order 1a (%)
-75.0 - -70.0	312,660	0.430	0.689	-0.031	0.062	99.894	99.998
-70.0 - -65.0	1,040,088	0.420	0.579	-0.026	0.049	99.969	100.000
-65.0 - -60.0	708,912	0.491	0.333	-0.019	0.043	99.988	100.000
-60.0 - -55.0	518,220	0.368	0.299	-0.012	0.041	99.992	100.000
-55.0 - -50.0	400,029	0.609	0.359	-0.008	0.040	99.978	100.000
-50.0 - -45.0	323,363	0.319	0.426	-0.004	0.040	99.989	100.000

-45.0 - -40.0	268,916	0.454	0.726	-0.001	0.040	99.968	100.000
-40.0 - -35.0	232,041	0.393	0.385	0.002	0.041	99.984	100.000
-35.0 - -30.0	205,145	0.332	0.497	-0.000	0.042	99.962	100.000
-30.0 - -25.0	185,365	0.354	0.357	0.002	0.042	99.980	100.000
-25.0 - -20.0	169,751	0.537	1.446	0.001	0.044	99.933	99.995
-20.0 - -15.0	159,479	0.374	2.067	-0.002	0.053	99.871	99.950
-15.0 - -10.0	151,557	0.370	2.182	-0.004	0.061	99.873	99.911
-10.0 - -5.0	256,390	0.384	1.291	-0.008	0.053	99.787	99.915
-5.0 - 0.0	292,563	0.461	0.989	-0.004	0.049	99.883	99.972
0.0 - 5.0	296,705	0.363	1.184	-0.005	0.048	99.956	99.995
5.0 - 10.0	260,476	0.822	1.486	-0.008	0.053	99.886	99.947
10.0 - 15.0	154,977	0.342	1.421	-0.005	0.053	99.908	99.941
15.0 - 20.0	164,197	0.321	1.010	-0.002	0.047	99.920	99.961
20.0 - 25.0	175,874	0.509	0.947	-0.001	0.048	99.853	99.931
25.0 - 30.0	190,818	0.273	1.017	0.001	0.046	99.887	99.939
30.0 - 35.0	210,979	0.365	0.843	0.001	0.042	99.937	99.983
35.0 - 40.0	239,732	0.339	0.560	0.003	0.040	99.960	100.000
40.0 - 45.0	278,680	0.319	0.713	0.002	0.039	99.984	99.997
45.0 - 50.0	333,805	0.692	0.941	0.002	0.041	99.920	99.971
50.0 - 55.0	414,414	0.659	0.881	0.001	0.042	99.904	99.972
55.0 - 60.0	543,974	1.006	0.975	0.002	0.042	99.921	99.981
60.0 - 65.0	744,475	1.448	1.320	0.003	0.049	99.830	99.922
65.0 - 70.0	1,088,505	1.990	1.211	0.005	0.050	99.880	99.959
70.0 - 75.0	283,154	1.511	1.724	0.008	0.088	99.024	99.487

Table 20: KRY18_03 Cross-line Statistics

6.8 System Checks and Calibration

6.8.1 Calibration Patch Tests

A full set of tests and checks were carried out for each vessel at the outset of 2018 INFOMAR survey operations. The accuracies of these outcomes were validated periodically through standard patch tests and QA'd by the on board data processors as survey operations were being undertaken.

Where values for roll, pitch and heading were deemed to require modification, these changes were generally applied in the CARIS vessel file by the on-board data processor. A full record of these modifications may be accessed by opening the vessel file for each specific survey. A description of the work-flow applied during vessel patch tests is illustrated below.

Further details concerning calibration and validation checks implemented during the 2018 survey leg are provided in the individual survey leg reports which are available on request from INFOMAR project management.

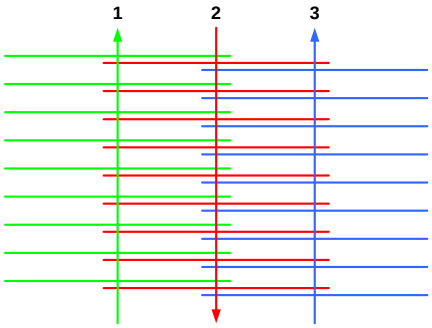
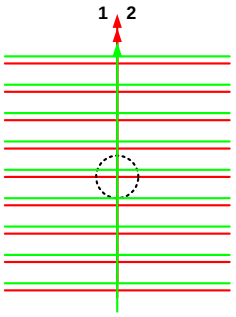
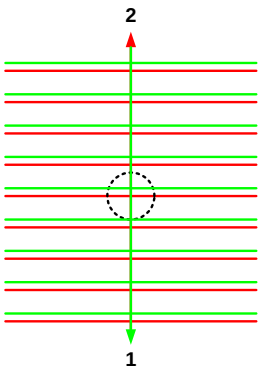
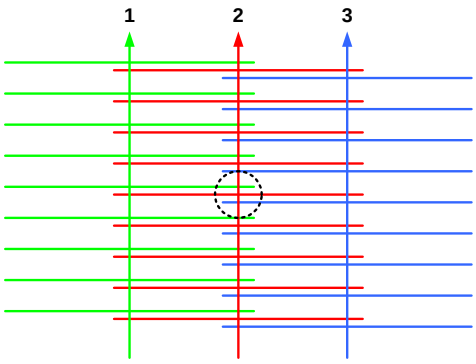
Roll Calibration	Timing Calibration
	
Pitch Calibration	**Heading Calibration**
	

Table 21: Standard Patch Test Calibration Run Lines

6.9 Sounding Density

Sounding densities for 2018 CHERISH Anglesey, Wales survey were examined in CARIS HIPS & SIPS software as part of a standard QC process, ensuring that the density of soundings in the survey area met requirements. Correct sounding densities are achieved and QA'd during data acquisition through setting appropriate vessel speeds, high ping rates (up to 50Hz) and high swath overlap (typically 15-25%, yielding a total seafloor search.
The final QC process was conducted as follows;

1. A "Base Surface" was created in CARIS HIPS & SIPS which was configured to display data density.
2. The surface was gridded at 2 metres and set to display areas with more than 9 "hits" per 2m² grid as GREEN, areas with 4-9 "hits" per cell as YELLOW and areas with less than 4 "hits" per cell as RED
3. The sounding density base surfaces are available as part of the final data delivery.
4. Through this QC process, UKHO sounding density requirements for shallow water surveys (9+ soundings within a 2 metre bin size) are demonstrated to meet the required specifications and figures illustrating the results of this QC analysis for each survey leg are provided in this section of this document.

There was complete coverage of >9 "hits" per $2m^2$ grid.

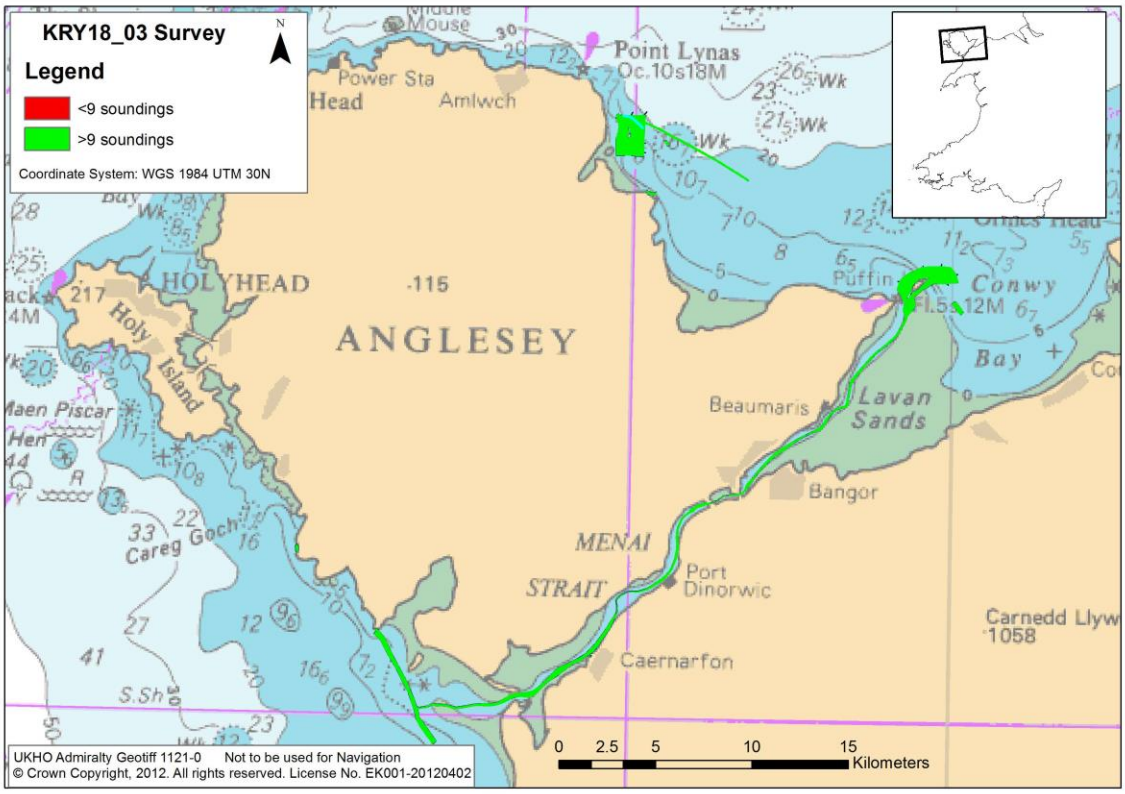


Figure 10: KRY18_03 Sounding Density, 2m² Base Surface

6.10 Ground truthing

Ground truthing was not carried out as part of the 2018 CHERISH Anglesey, Wales survey.

7 Data Deliverables

7.1 Data Structure and Management

Survey Data was stored on-board the survey vessels within a standardised directory structure system. The table below provides a generalised overview of the system. This structure can vary slightly from vessel to vessel on given survey legs due to varying requirements.

Main Directory	Sub Directories	Comments
Administration	GIS	
	Images	
	Party-Chief	
	Reporting	
Geophysical	SBP	
Multibeam	CARIS	Final, fully-cleaned soundings
	Deliverables	Standard outputs
	GSF	All tidal and motion corrections applied, but may have spurious soundings
	MBES-Raw-Data	Raw data
	Processing Log	
Positioning	Navigation	
Singlebeam	EA400	
Sound-Velocity	CARIS-SVP	

Table 22: Survey Data Directory Structure

7.2 Data Deliverables

The table below lists the standard deliverables that are available once final data processing is completed.

Data Deliverable	Description
CARIS Project	CARIS HIPS & SIPS project containing all finalised survey data separated by survey vessel and survey leg.
MBES xyz soundings	Hydrographically corrected depth soundings for charts
Grids and Raster images	Bathymetry Backscatter (Seabed Texture) Shaded Relief Fledermaus DTMs / Scene files
Geotiff imagery and Google	Geo-referenced TIFF images

Earth files.	KMZ files can be opened using Google Earth.
Shp files / Point information	Spatial coverage (Survey area) Ship tracklines. SVP locations Investigations (Wreck and Shoal)
Auxiliary Datasets	CHIRP Sub-bottom data SBES data Daily Progress Reporting H-Forms Crew Lists Incident Records
Report of Survey	Over-arching Report of Survey Document detailing survey methodologies and data delivery

Table 23: Survey Deliverables

To get a copy of data associated with the survey, please request it from the CHERISH project by contacting info@cherishproject.eu.

8 Survey Results

8.1 Bathymetry

The GSI acquired high resolution bathymetry using MBES mapping systems with the R.V. Keary in from four locations around Anglesey Wales from 05/08/2018 to 22/08/2018. The four locations are described for the purposes of this report as: Dulas Island, Puffin Island, Northeast Menai Strait, Southwest Menai Strait.

The resulting datasets were acquired to IHO Order 1a standard or higher. Figures illustrating the resultant bathymetry coverage and corresponding track-lines are provided below.

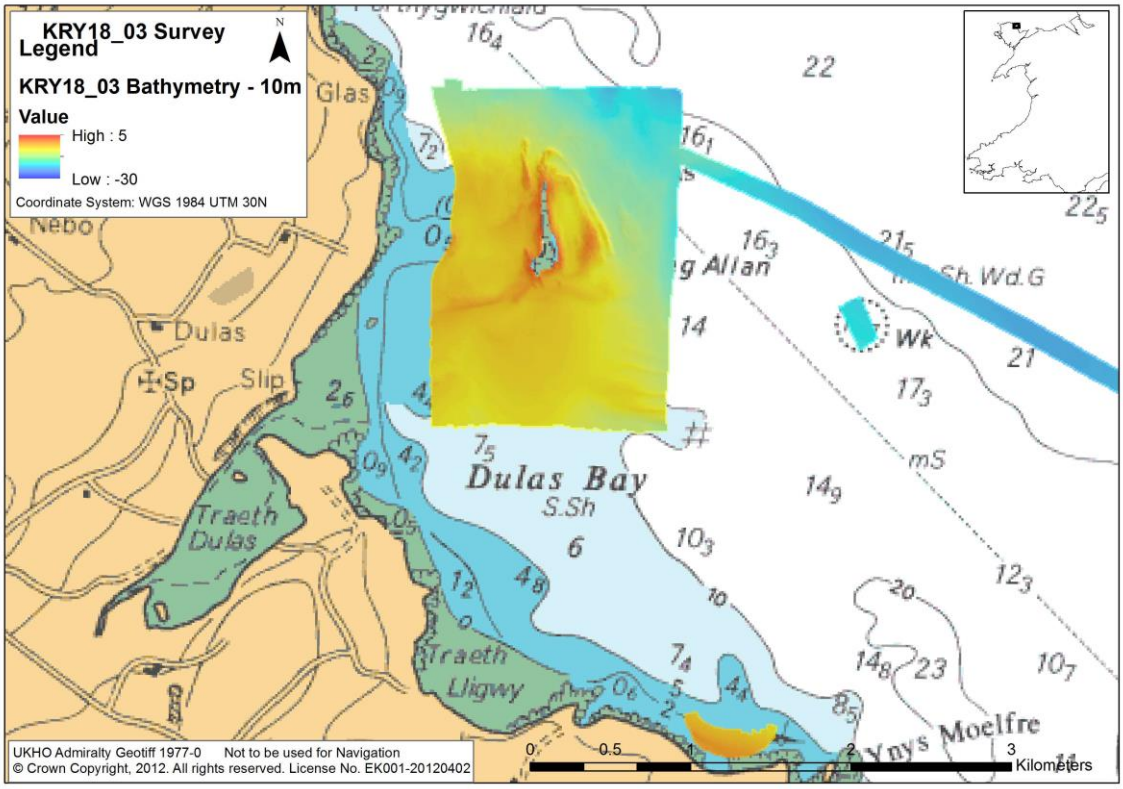


Figure 11: Bathymetry coverage for Dulas Island and shipwreck surveys

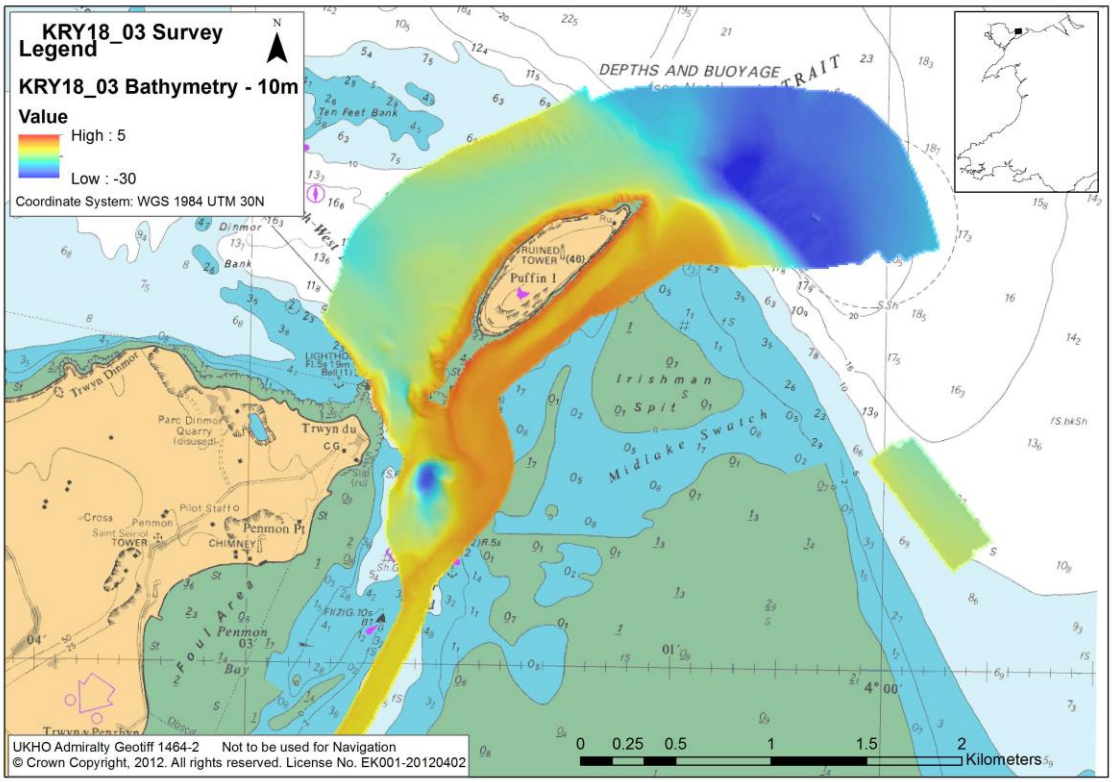


Figure 12: Bathymetry coverage for Puffin Island and shipwreck surveys

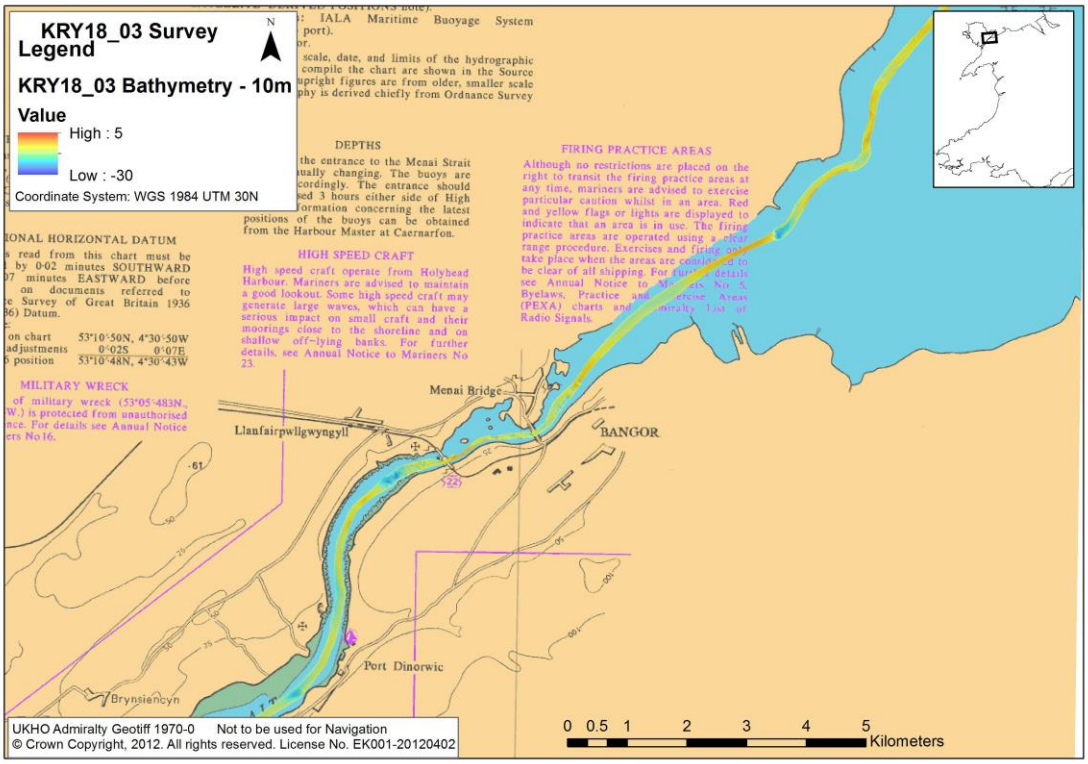


Figure 13: Bathymetry coverage for NE Menai Strait

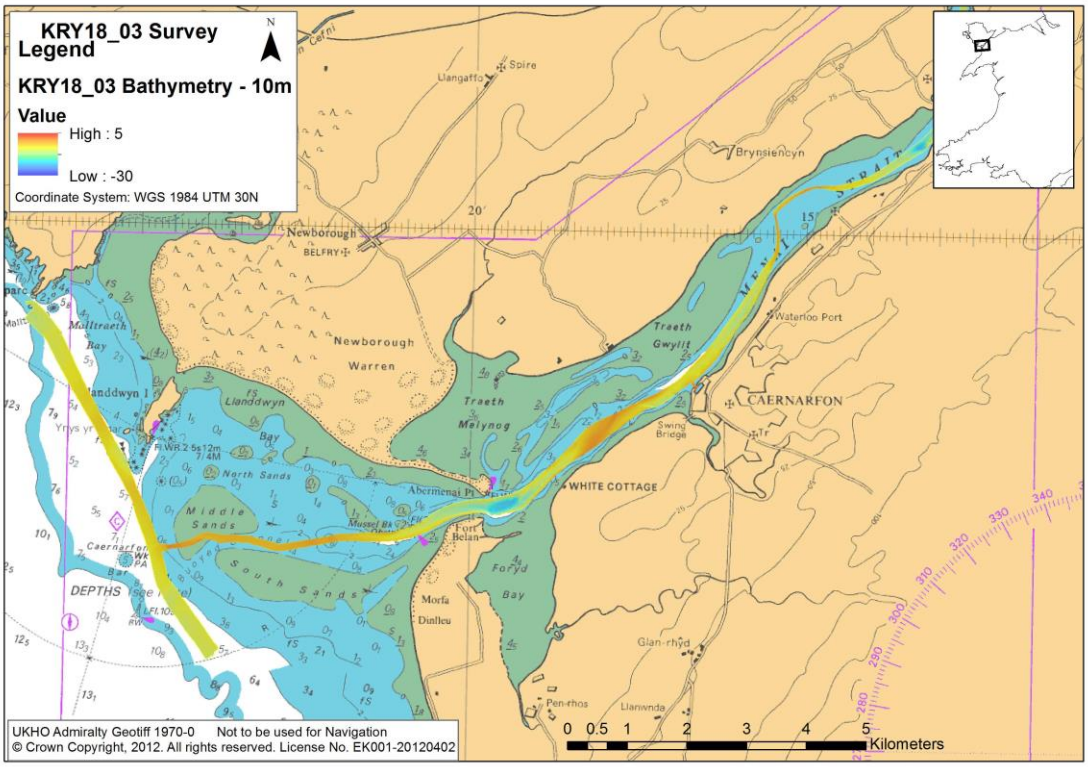


Figure 14: Bathymetry coverage for SW Menai Strait

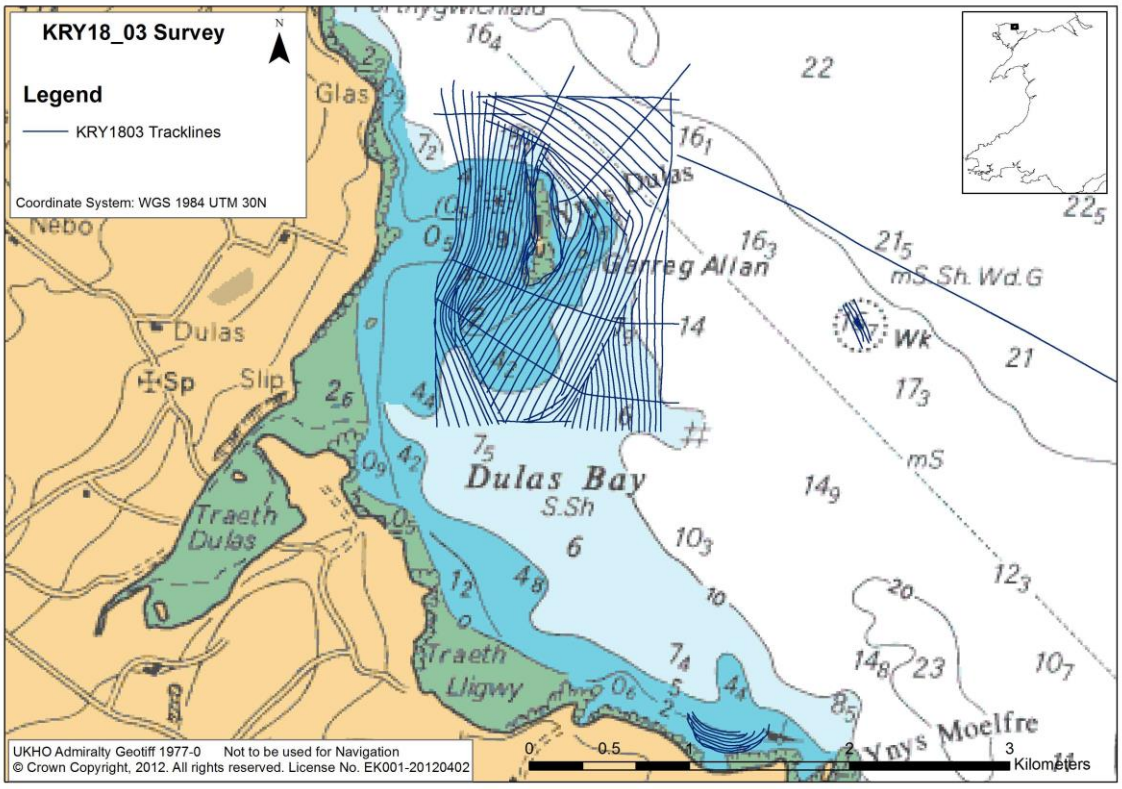


Figure 15: Vessel tracklines for Dulas Island and shipwreck surveys

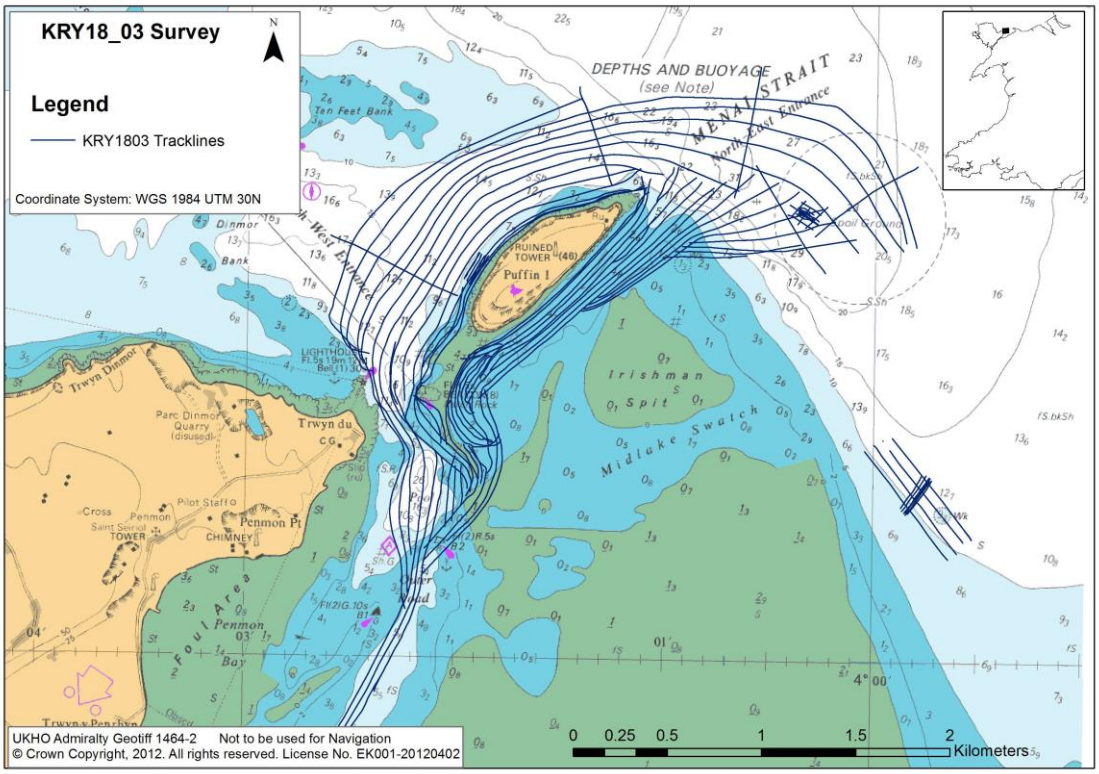


Figure 16: Vessel tracklines for Puffin Island and shipwreck surveys

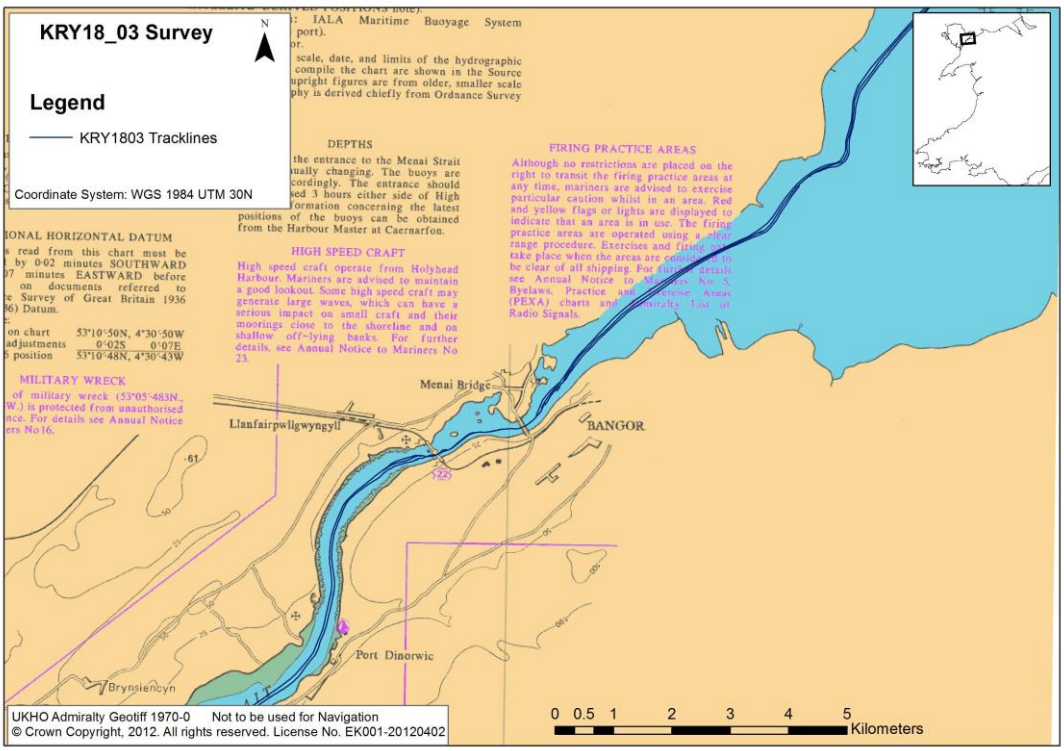


Figure 17: Vessel tracklines for NE Menai Strait

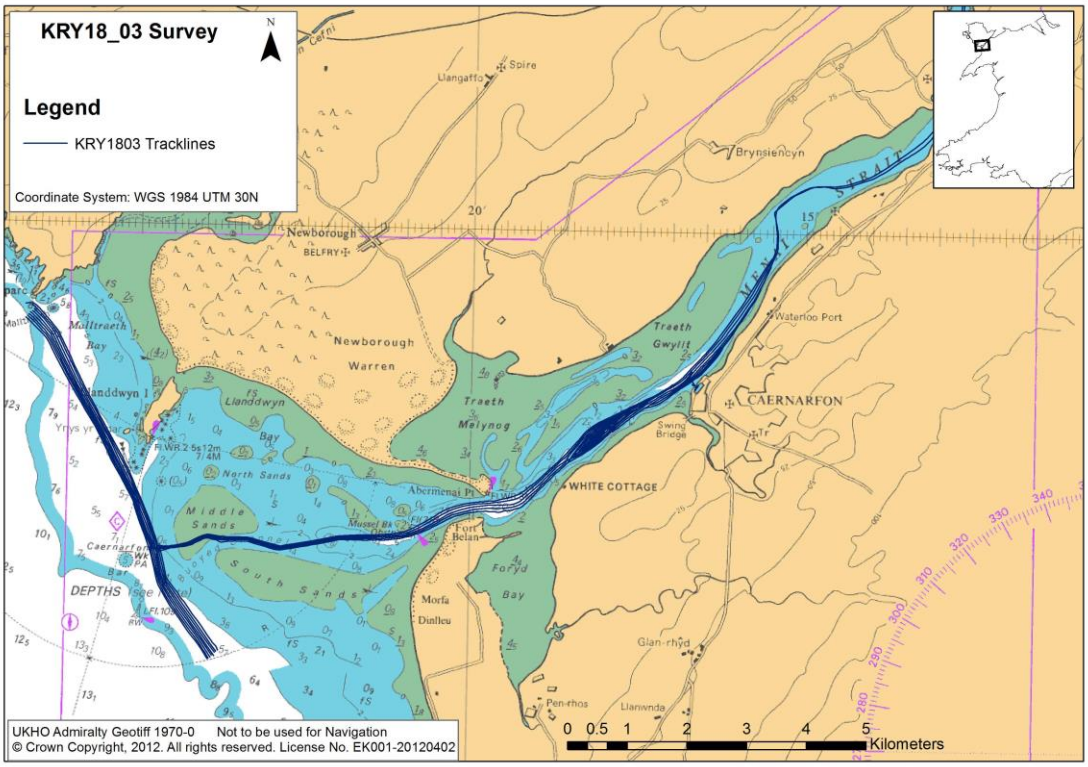


Figure 18: Vessel tracklines for SW Menai Strait

8.2 Backscatter Data

Backscatter from KRY18_03 has been compiled into the Backscatter mosaics shown in the figures below. Harder substrate (e.g. bedrock) returns a higher backscatter signal than softer substrate (e.g. muds).

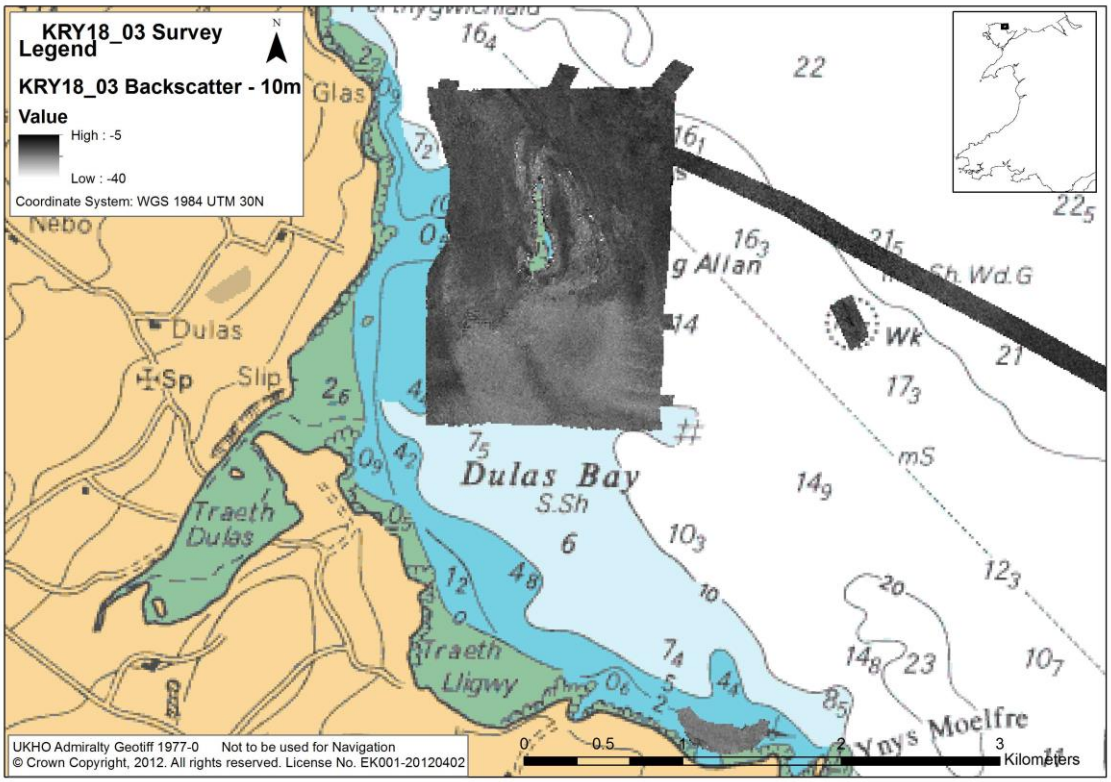


Figure 19: Backscatter coverage for Dulas Island and shipwreck surveys

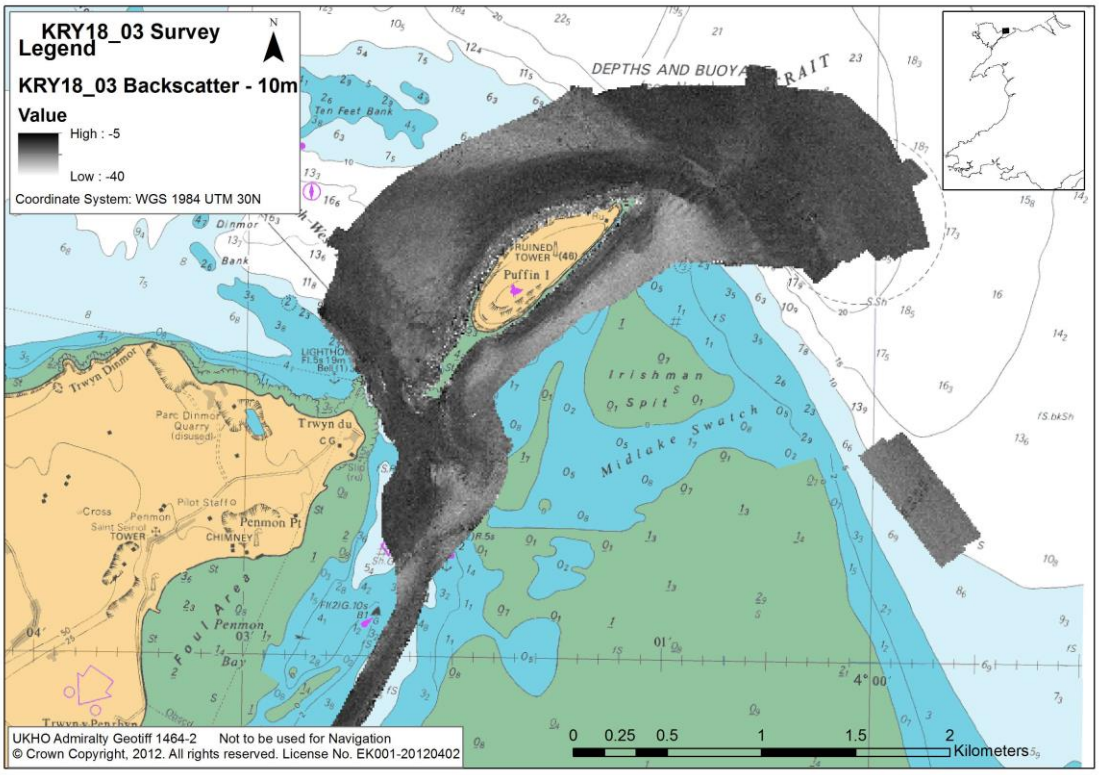


Figure 20: Backscatter coverage for Puffin Island and shipwreck surveys

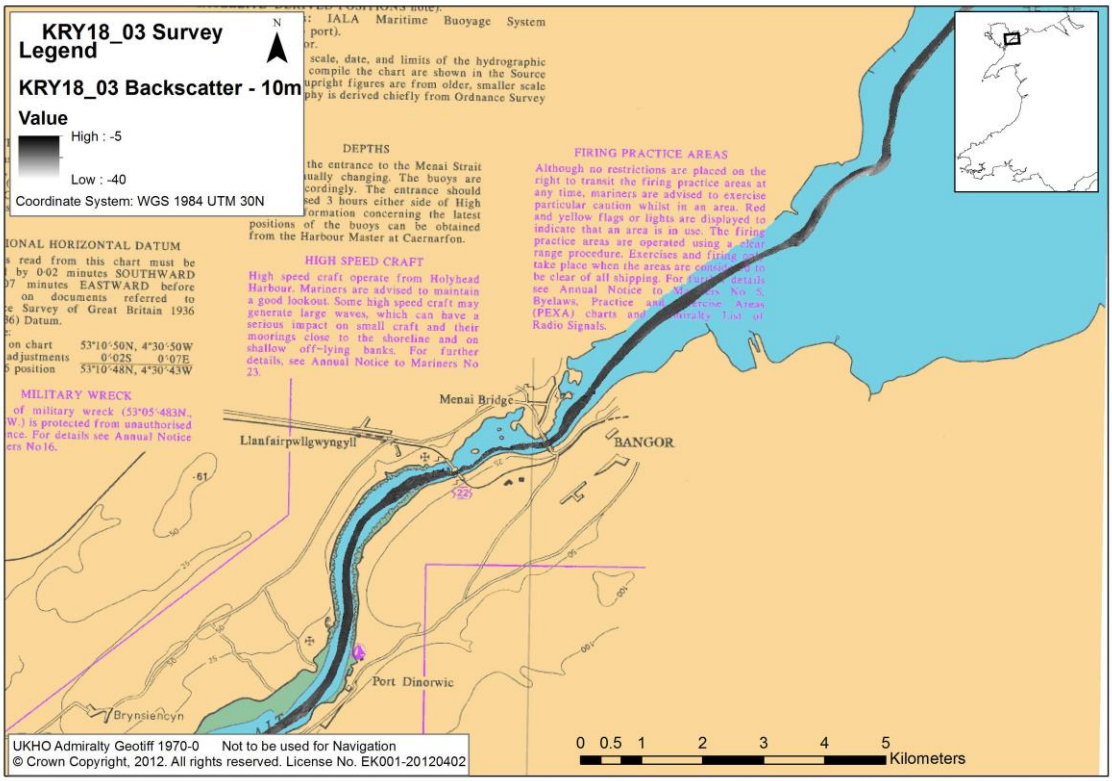


Figure 21: Backscatter coverage for NE Menai Straits

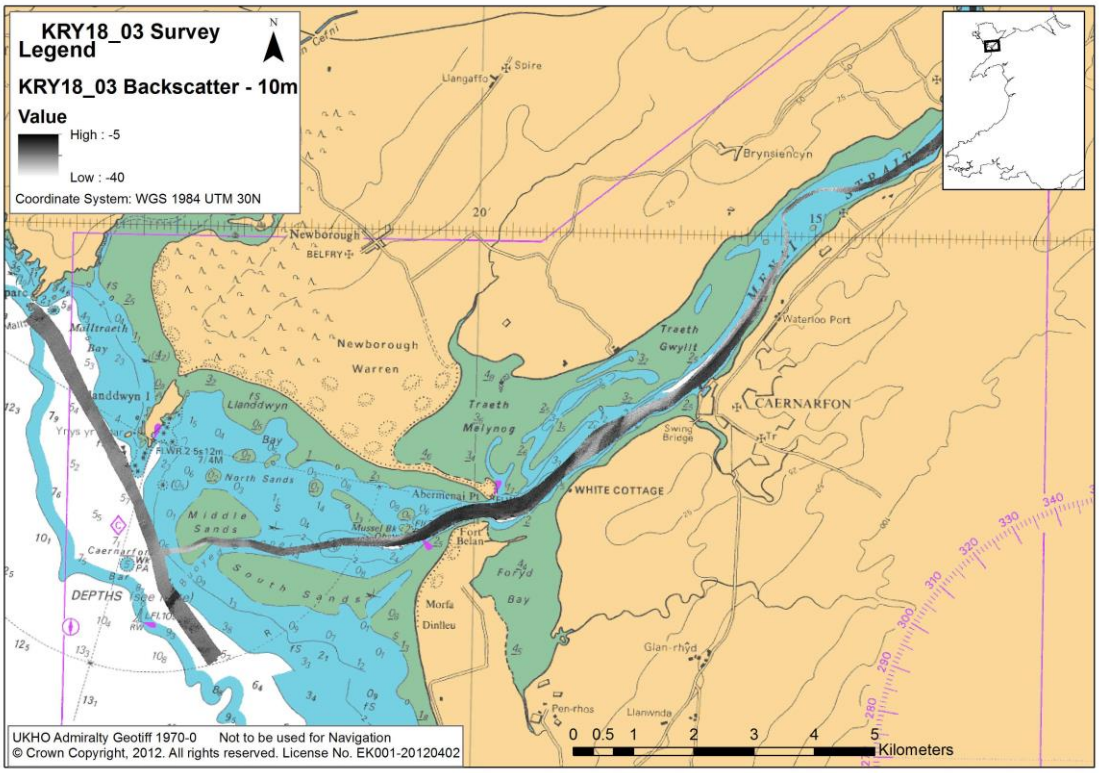


Figure 22: Backscatter coverage for SW Menai Straits

8.3 Shallow Seismic Data

Shallow seismic data was acquired by the R.V. Keary during the 2018 Anglesey, Wales 2018 survey.

Details of the dataset acquired are provided in Section 4.3 and the locations of the various ship track-lines may be viewed in Section 8.1 of this document.

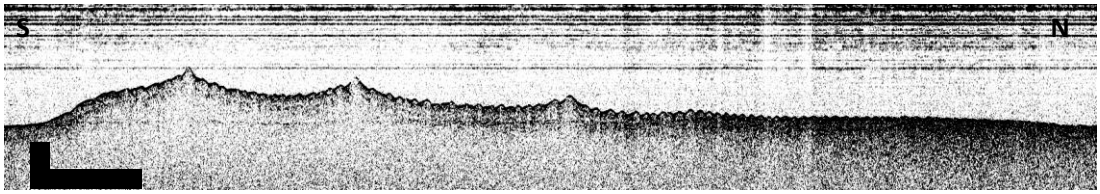


Figure 23: Example of shallow seismic data from Line 0222. Vertical scale bar 5m, horizontal scale bar 50m

8.4 Wreck Surveys

Fifteen shipwrecks were assessed for surveying. Six shipwreck surveys were attempted. The possible remains of two shipwrecks (Seahow, Wern) were recorded, and a H525 was produced for the Seahow (See Annex 2). Shipwrecks that were surveyed or assessed for survey include, by area:

Table 24: Wrecks SW of Menai Strait

Wreck	Northing	Easting	Result
Euphrates	53° 11.766’	-4° 30.378’	Too close to rocks with onshore winds increasing when assessed for survey
Kyle Prince	53° 11.448’	-4° 30.414’	Carried out detailed wreck survey in location but nothing remains
Kinya	53° 9.519’	-4° 26.914’	Partially exposed at low tide, too shallow for R.V. Keary
Bothilde Russ	53° 10.711’	-4° 29.363	Too shallow for R.V. Keary
South Sands wreck 1	53° 6.656’	-4° 21.583’	Too shallow for R.V. Keary
South Sands wreck 2	53° 6.572	-4° 21.604	Too shallow for R.V. Keary
South Sands wreck 3	53° 6.711’	-4° 21.501’	Too shallow for R.V. Keary

Watkins S Nesbit	53° 8.777’	-4° 24.84’	Too shallow for R.V. Keary
Athena	53° 9.366’	-4° 25.296’	Too shallow for R.V. Keary

Table 25: Wrecks near Puffin Island

Wreck	Northing	Easting	Result
Pioneer	53° 19.128’	-4° 1.926’	No remaining debris found
Unnamed wreck	53° 18.899’	-4° 1.873’	Too shallow for R.V. Keary
River Loyne	53° 18.424’	-3° 59.665’	Possible Debris Field surveyed
Seahow	53° 19.275’	-4° 00.348’	Surveyed

Table 26: Wrecks near Dulas Island

Wreck	Northing	Easting	Result
Royal Charter	53° 21.530’	-4° 14.284’	Nothing Found
Wern	53° 22.965’	-4° 13.472’	Found and surveyed remains of cargo consisting of granite setts

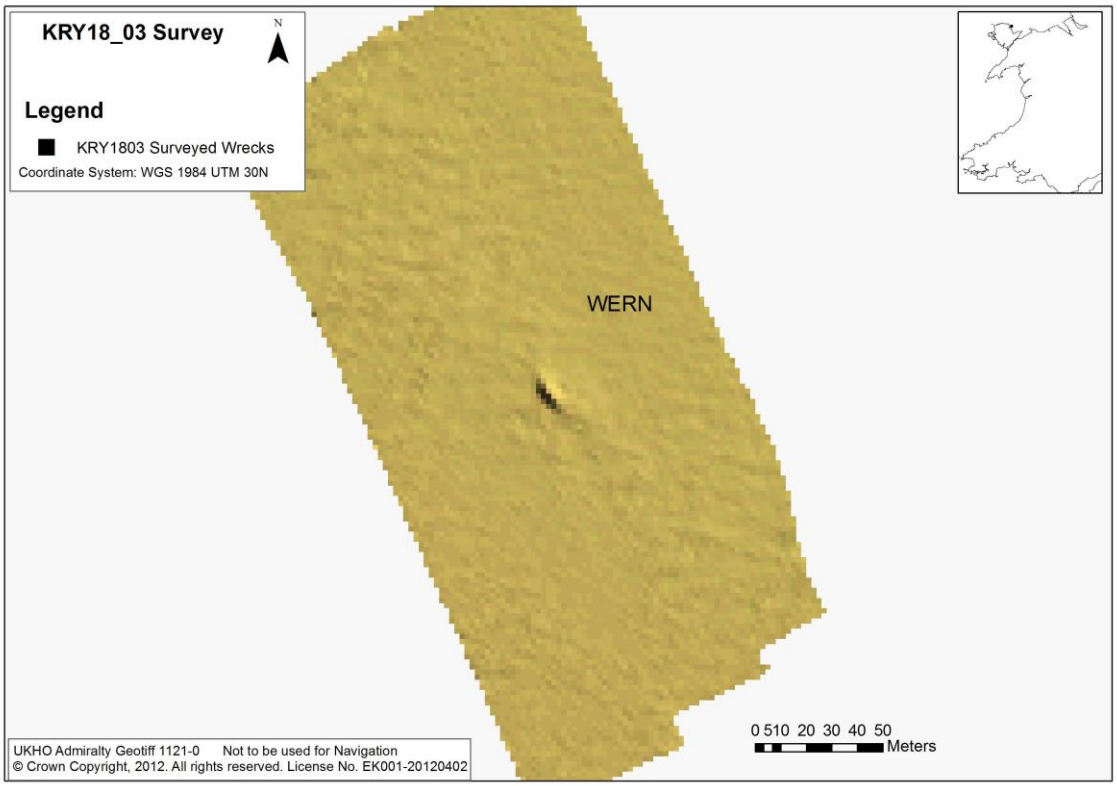
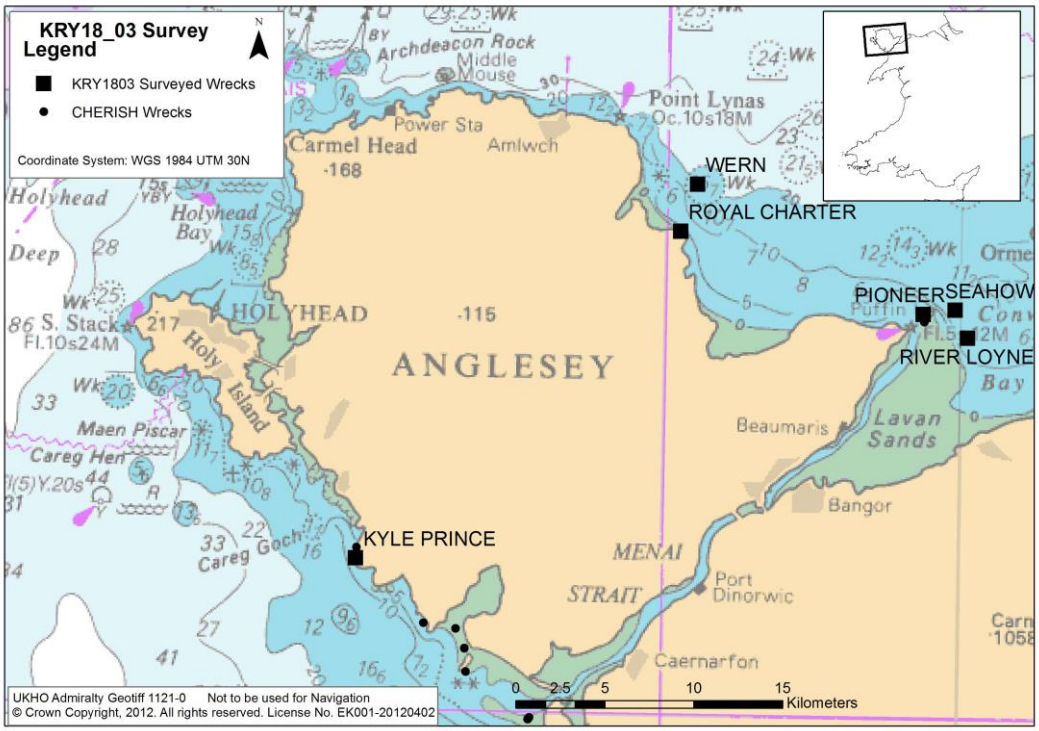


Figure 24: Wreck survey of the Wern. See



Figur e 3 for location

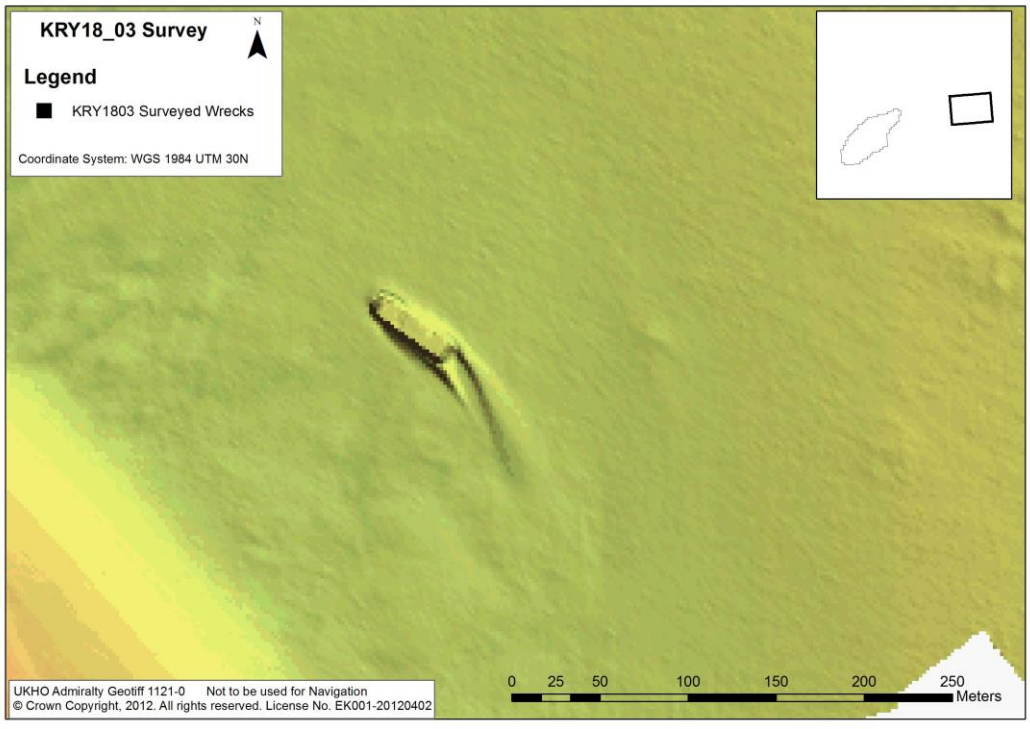


Figure 25: Wreck Survey of the Seahow, off Puffin Island.

Wrecks which were not found during KRY1803 may be either buried or destroyed.

8.5 Seabed Contacts

Multiple contacts requiring reporting to UKHO through a H102 form were made during the course of the project and this is detailed in section 8.6. All sounding data has been supplied to the UKHO.

8.6 Shoal Investigations (H102 Forms)

Three H102 forms were submitted to the UKHO arising from the CHERISH Anglesey, Wales survey 2018. These are detailed in Annex 3 with a total of 21 observations made.

H102-KRY18_0-001
Observed depths differ from charted depths in a number of locations throughout the area surveyed
H102-KRY18_0-002
Observed depths differ from charted depths in a number of locations throughout the area surveyed
H102-KRY18_0-003
Observed depths differ from charted depths in a number of locations throughout the area surveyed

8.7 Marine Mammal Observations

Marine mammal observation was conducted following the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (August 2017). Details on marine mammal observations can be found in Annex 3: MMO Report CHERISH Anglesey, Wales.

8.8 Seabed Sampling and Ground-truthing

Seabed sampling was not carried out as part of the 2018 CHERISH Anglesey, Wales survey.

9 Conclusion

9.1 Conclusions and Final Remarks

All survey work was carried out to IHO S-44 Order 1a Standard.

Bathymetry datasets from 2018 CHERISH Anglesey, Wales survey leg has been combined, finalised and H.102 notes delivered to UKHO for updating nautical charts and publications in offshore waters to improve safety for mariners.

Dulas and Puffin Islands and their surroundings were successfully surveyed to drying heights despite challenging current conditions. Bathymetry will be combined with topographical maps of island to provide seamless offshore-onshore maps. These maps will provide the framework for understanding the impacts of climate change to heritage in these coastal regions.

Surveyed wrecks may be re-surveyed before the completion of the CHERISH project (ending 2021) to assess the impacts of climate change on their preservation

Information detailing how these specifications were met forms the basis of this Report of Survey document.

10 References

IHO Standards for Hydrographic Surveys (S-44) 5th Edition 2008

JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys: August 2017

NP 40 Irish Coast Pilot Sailing Directions

UK Civil Hydrography Programme – Survey Specification 2013

UKHO Guides for UKHO notices NP100

UKHO ENC GB302049

UKHO VORF Model

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Geological Survey
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CHERISH
Newid Hinsawdd a Threftadaeth yr Afordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

EU Funds: Ireland Wales Programme 2014-2020

Annex 1

Foreign & Commonwealth Office Permission

Anglesey, Wales Survey 2018

Foreign & Commonwealth Office

Date: 31/07/2018

Ref: 83/2018

The Maritime Policy Unit (Legal Directorate) of the Foreign and Commonwealth Office presents its compliments to the Irish Embassy and has the honour to refer to the Irish Embassy's application requesting permission to undertake research cruises by RV Keary in the territorial waters of the UK**.**

The appropriate United Kingdom authorities have been informed of the research cruise RV Keary KRY18_CHERISH for the periods 07 - 23 August 2018 and hereby give approval for the cruise, subject to the following conditions being met:

The marine scientific research is to be undertaken in conformity with the information specified in the research application and the relevant provisions of UK and international law. Plans for any changes in activities or additional activities are to be communicated in advance to the Maritime Policy Unit, Foreign Commonwealth Office by email to msrapplications@fco.gov.uk.

If, in the course of the research activity any wreck, whether or not including valuable cargo, is discovered the ordinary law would apply. Certain historic/dangerous wrecks are protected by the Protection of Wrecks Act 1973 and The Protection of Military Remains Act 1986 and the Marine and Coastal Access Act (MCAA) 2009. Any removal from a wreck may require a Marine Licence. Any person recovering wreck material (of any kind not just cargo but also any parts of a ship wreck or its contents) and bringing it into UK waters (12 nm limit) is required by law to land it in the UK and report it to the Receiver of Wreck via email to row@mcga.gov.uk.

The cruise is in an area which is crossed by both in and out of service submarine cables, no seabed intrusive equipment shall be deployed within one nautical mile of an in service cable. The reference data for these cables should be available from the KISCA charts website: www.kis-orca.eu and/or Subsea Cables UK Secretary (www.subseacablesuk.org.uk)

If it is necessary to deploy seabed intrusive equipment within one nautical mile of an in service cable, a representative for the cruise will need to contact the relevant submarine cable owner/operator for prior approval It is requested that the vessel should at all times comply with the International Regulations for Preventing Collisions at Sea 1972 (as amended) as set out in the Schedule to the Merchant Shipping (Distress Signals and Prevention of Collisions) Regulations 1989 (SI 1989 No 1798). In particular, the vessel should comply with the requirements of Rule 10 of the Collision Regulations when operating within the vicinity of traffic separation

schemes approved by the IMO. In this connection, the Embassy's attention is drawn to the Admiralty Notice to Mariners No 17 of 99 and Merchant Shipping Notice M1448.

Attention is also drawn to:

a) The safety zone established in accordance with international law and extending to 500 metres around all water off-shore installations (it is an offence to enter such safety zones without permission from the Minister of State for Energy (Part III of the Petroleum Act 1987));

b) Oil and Gas Development Areas which are marked on Admiralty Charts.

The Department for Environment, Food and Rural Affairs would like the following to be brought to the Irish Embassy's attention; the master of the cruise vessel must be made aware of the possibility of encountering fixed, poorly lit and marked, fixed fishing gear. Care should be taken not to interfere with the activities of commercial fishing vessels when undertaking scientific trials. In the event of any fouling the vessel should report details to the Marine Management Organisation (England), Northern Ireland Department of Agriculture and Rural Development (Northern Ireland) or the local Marine Scotland Fishery Office, at the earliest opportunity.

The MMO currently have 4 byelaws in place within Marine Protected Areas to protect reef features from bottom towed gear:

- Inner Dowsing, Race Bank and North Ridge Site of Community Importance (SCI)
- Haisborough, Hammond and Winterton SCI
- Start Point to Plymouth Sound and Eddystone SCI
- Land's End and Cape Bank SCI

You must comply with these byelaws and not use bottom towed gear where it is not permitted within the sites.

Please see the link below for more information:

https://www.gov.uk/marine-conservation-byelaws#current-mmo-byelaws

If working inshore (0-6nm) contact the local Inshore Fisheries and Conservation Authority. http://www.association-ifca.org.uk/ and should be aware of the Marine Protected Areas and any by-laws attached to these.

Some activities may be exempt from the requirement of a marine licence. Often these exemptions are subject to certain conditions that must be met before you carry out the activity. Further information on when a marine licence is needed, including where an exemption may apply, can be found on the guidance on marine licences. You may need to notify the appropriate licensing authorities that you intend to carry out the activity before you do it and include details of how you will comply with any conditions associated with the exempt activity. If you are unclear whether an exemption applies, or for further advice and guidance on marine licensing issues please email marine.consents@marinemanagement.org.uk (England and Wales), marinelicensingteam@doeni.gov.uk (Northern Ireland) or ms.marinelicensing@scotland.gsi.gov.uk (Scotland). If working inshore (0-6nm) contact the local Inshore Fisheries and Conservation Authority. http://www.association-ifca.org.uk/

It is the responsibility of the applicant to adhere to all applicable UK and EU marine environment protection law. This includes an assessment in relation to activities that may injure or disturb a European Protected Species. The relevant information on such requirements can be found, for English and Welsh territorial waters and the UK

offshore marine area in the draft European Protected Species guidance available from the Joint Nature Conservation Committee (JNCC) upon request from the following email address seismic@jncc.gov.uk and for Scottish territorial waters via the guidance on The Protection of Marine European Protected Species From Injury and Disturbance.

As a condition of entry, in accordance with article 249 of UNCLOS, the researching State shall provide access to all data collected from within waters under UK jurisdiction. Preliminary reports are to be submitted no later than 3 months of completion of the research, with a short expedition narrative describing the expedition and its preliminary results, and the ships expedition track chart (Latitude and Longitude positions to be supplied as MS Excel spreadsheet or Arc GIS shapefile). Subsequently, final cruise reports, and all data resulting from research, are to be submitted within 6 months of the completion of the research, including an assessment of the results of the expedition. These should be in digital format and submitted to:

- Foreign and Commonwealth Office, Maritime Policy Unit by email to msrapplications@fco.gsi.gov.uk
- UK Hydrographic Office, Outreach and National Engagement Manager, UK Hydrographic Office, Taunton, Somerset TA1 2DN (please make any bathymetric data collected in UK territory waters available to the UKHO for charting) / marine.life@ukho.gov.uk & National.Relations@ukho.gov.uk
- Paul McGarrigle, British Oceanographic Data Centre: Proudman Oceanographic Laboratory, Joseph Proudman Building, 6 Brownlow Street, Liverpool L3 5DA / enquiries@bodc.ac.uk
- Jane Thompson, RSU Operations, NERC Research Ship Unit, National Oceanographic Centre, Empress Dock, Southampton SO14 3ZH / vmt@noc.ac.uk
- JNCC Offshore Survey Programme Manager, JNCC, Monkstone House, City Road, Peterborough, PE1 1JY, UK / offshoresurvey@jncc.gov.uk. Please provide 2 copies of all publications arising out of the expedition.
- Marine Laboratory Aberdeen (PO Box 101, 375 Victoria Road, Aberdeen AB11 9DB)
- Maritime and Coastguard Agency, Bay2/22, Spring Place, 105 Commercial Road, Southampton, SO15 1EG (please make any bathymetric data collected in UK territory waters available for charting)

The Maritime Policy Unit avails itself of this opportunity to renew to the Irish Embassy the assurances of its highest consideration.

MARITIME POLICY UNIT
LEGAL DIRECTORATE
FOREIGN AND COMMONWEALTH OFFICE
LONDON
SW1A 2AH

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

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Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

EU Funds: Ireland Wales Programme 2014-2020

Annex 2

Report of Wreck Investigation - Seahow Anglesey, Wales Survey 2018

REPORT OF WRECK INVESTIGATION Wreck No: N/A

2

Ship/Unit RV KEARY HMOI No:

Survey: KRY18_03

Date located: 20/08/2018 Date Examined/Swept: 06/02/2019

Listed Position: º . ‘N º . ‘W

Fixed Position: *53* º *39* . *434* ‘N *6* º *10* . *993* ‘W

Method of Positioning: MBES GPS Accuracy (2,447σ): 0.2 metres

Horizontal Datum: WGS84

Depth Data: (VORF LAT)	Swept Clear:	N/A	metres	No sweep, data from EM2040D MBES System
	Swept Foul:	N/A	metres	
	Least E/S Depth:	24.49	metres	
	General Depth:	28.0	metres	
	Scour Depth:	N/A	metres	

Tidal observations at: Tidal correction derived from real time GPS height
Cotidal adjustments by:

Contact Data:	Sonar Height:	2.5	metres	
	Sonar Length:	51.5	metres	
	Sonar Width:	13.4	metres	
	Orientation:	*135* º / *315* º	(Bows: *N/A*º)	

Sonar Signal Strength: Nil Poor Moderate **Strong** Unknown

Magnetic Anomaly: Nil Poor Moderate Strong **Unknown**

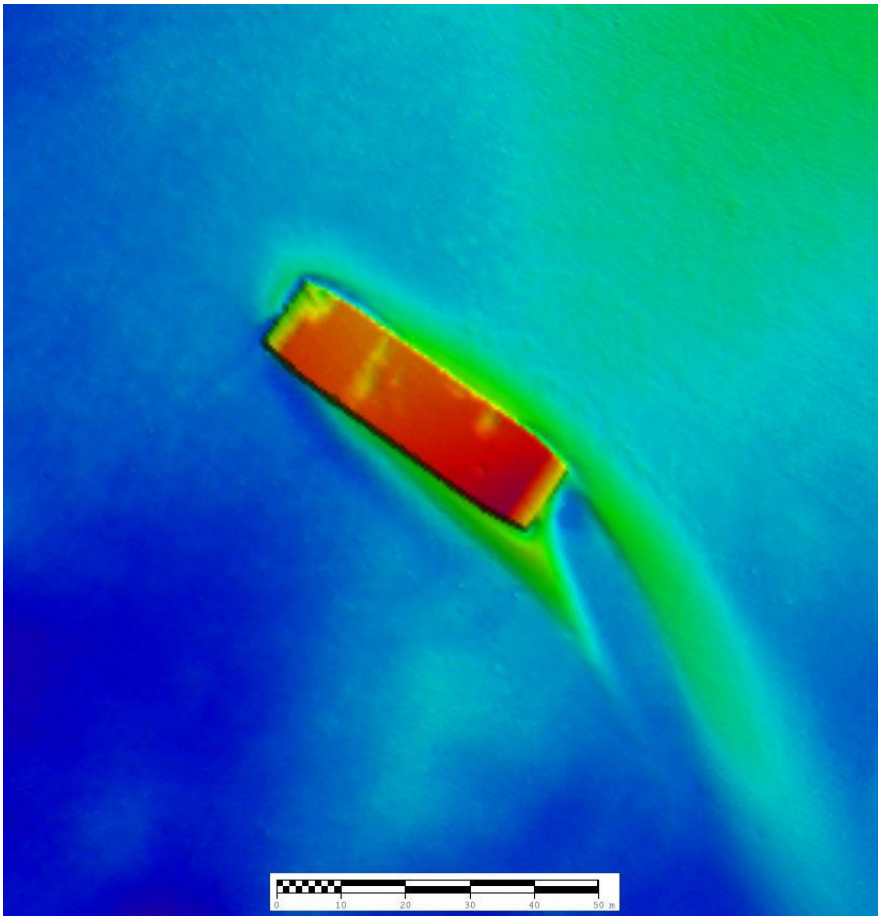
Scour Length: N/A Direction (towards): º

Seabed Texture: Flat sandy

Debris Field: N/A Length: metres Direction (towards): º

Buoyage: N/A

Description (include attitude and whether intact): The main structure of the wreck is clearly visible, but there is no clear detailing to indicate type of vessel. The wreck is orientated 135/315 with no distinguishing features indicating the bow from the stern. The wreck lies on a sandy bottom and there are some sand waves building from the south-eastern end of the wreck.


0
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30
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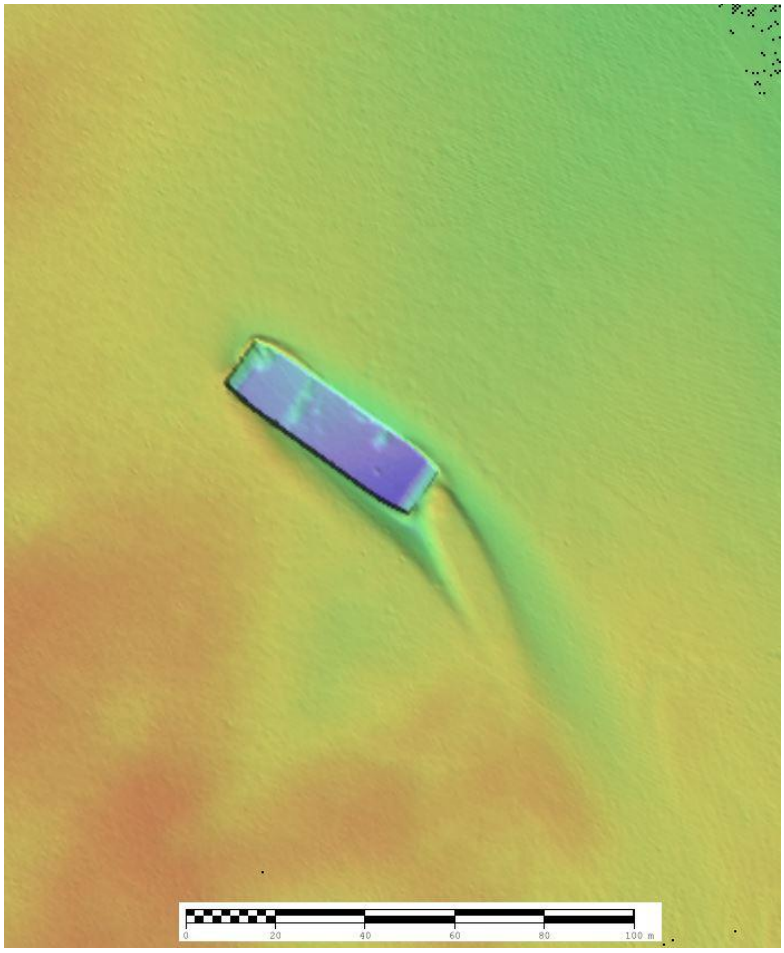
50 m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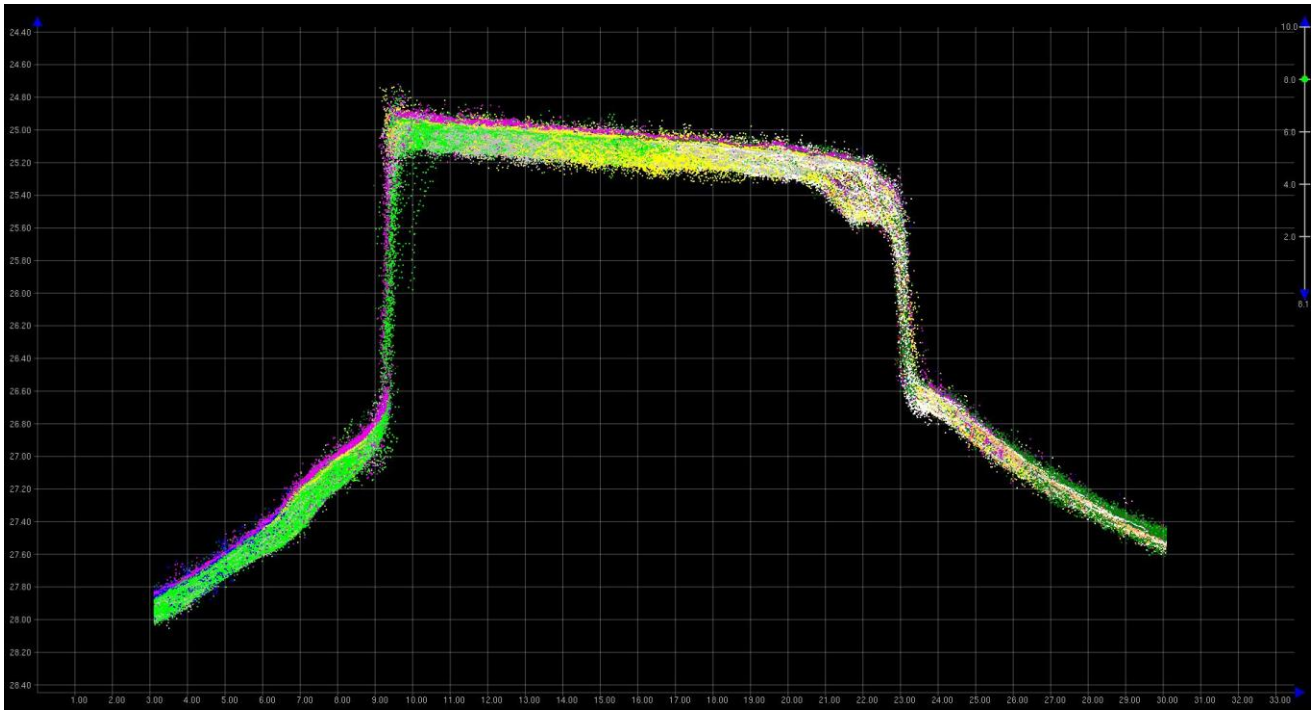

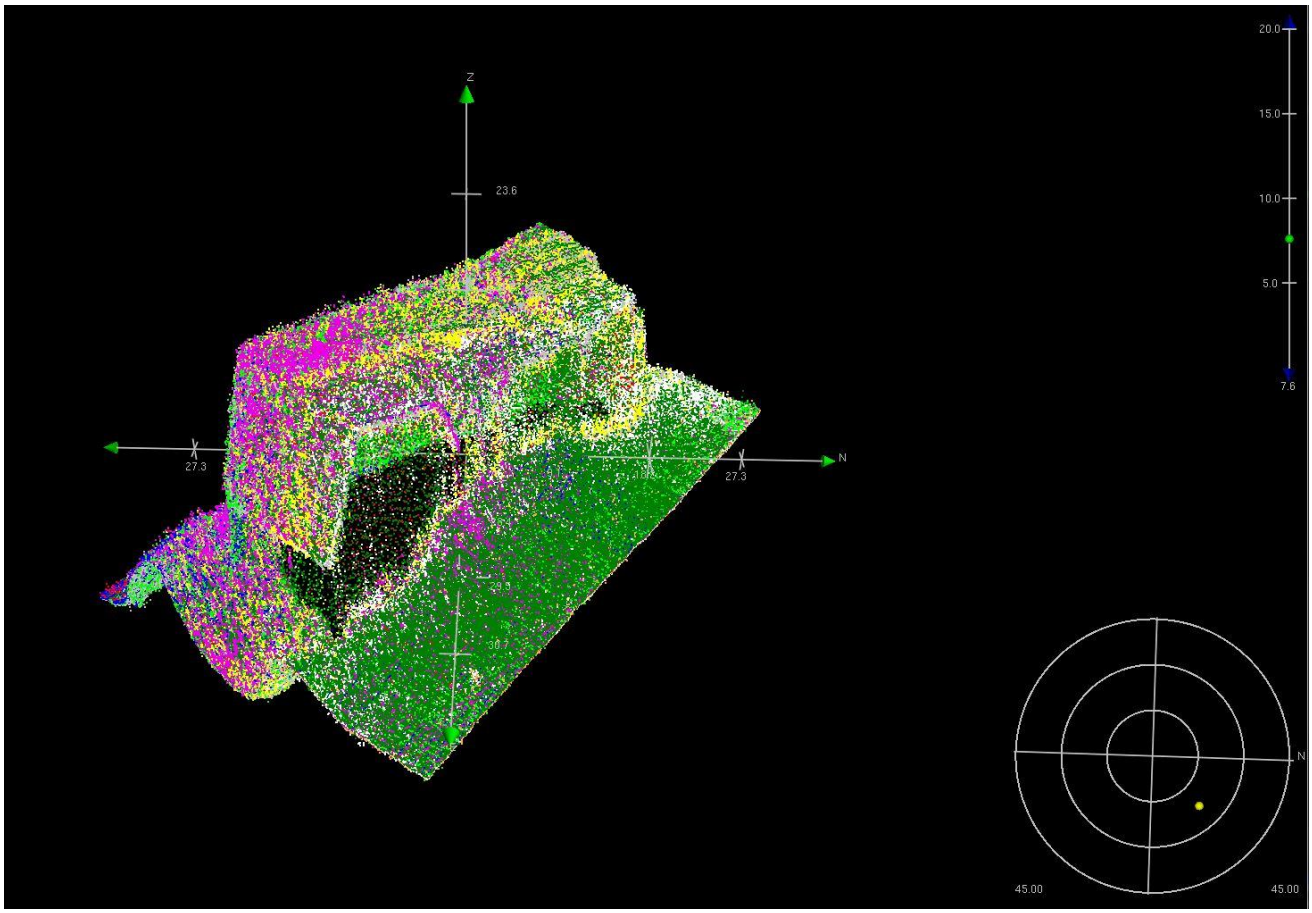

Approved: Niall Finn Data Processor Date: 06/02/2019

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

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EU Funds: Ireland Wales Programme 2014-2020

Annex 3

Hydrographic Note 102
Anglesey, Wales Survey 2018

HYDROGRAPHIC NOTE

H.102
(V8.0 Oct 2014)

3.

Date	13/09/2018		Ref. Number	H102-KRY18_03-001		
Name of ship or sender	Geological Survey of Ireland R.V. Keary					
IMO number if applicable	-					
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland					
E-mail/Tel/Fax of sender	inshore.infomar@gmail.com					
General Locality	Between 400 m and 2 km off North east coast of Anglesey, Wales					
Subject	Multiple observations on area off the North east coast of Anglesey, Wales					
Position *(see Instruction 2)*	Latitude	See following pages		Longitude	See following pages	
	GPS	POSpac -PPK	Datum	WGS 84	Accuracy	0.1m
Admiralty Charts affected	1977-0			Edition	Unknown	
Latest Weekly Edition of Notice to Mariners held	Unknown					
Replacement copy of Chart No (*see Instruction 3)*	**IS NOT** required					
ENCs affected						
Latest update disk applied	Week:					
Make, model and or age of ECDIS if applicable	Qinsy/Caris					
Publications affected (NP/DP number, Edition No.)	Unknown					
Date of latest supplement/update, page & Light List No. etc	Unknown					

Details of anomaly / observation:
Area surveyed as part of Irish-Wales CHERISH project. Observed depths differ from charted depths in a number of locations throughout the area surveyed. This data has not yet been finalised.

Data acquired by R.V. Keary:
- equipped with Kongsberg EM2040D and POSmv 320 Wavemaster. All depths are reduced to VORF LAT using GPStide methods. Navigation data is reprocessed using PP-RTX and transformed to ETRS89.

Name of observer/reporter	Niall Finn
H.102A Submitted No	H.102B Submitted No
Tick box if not willing to be named as source of this information	☐

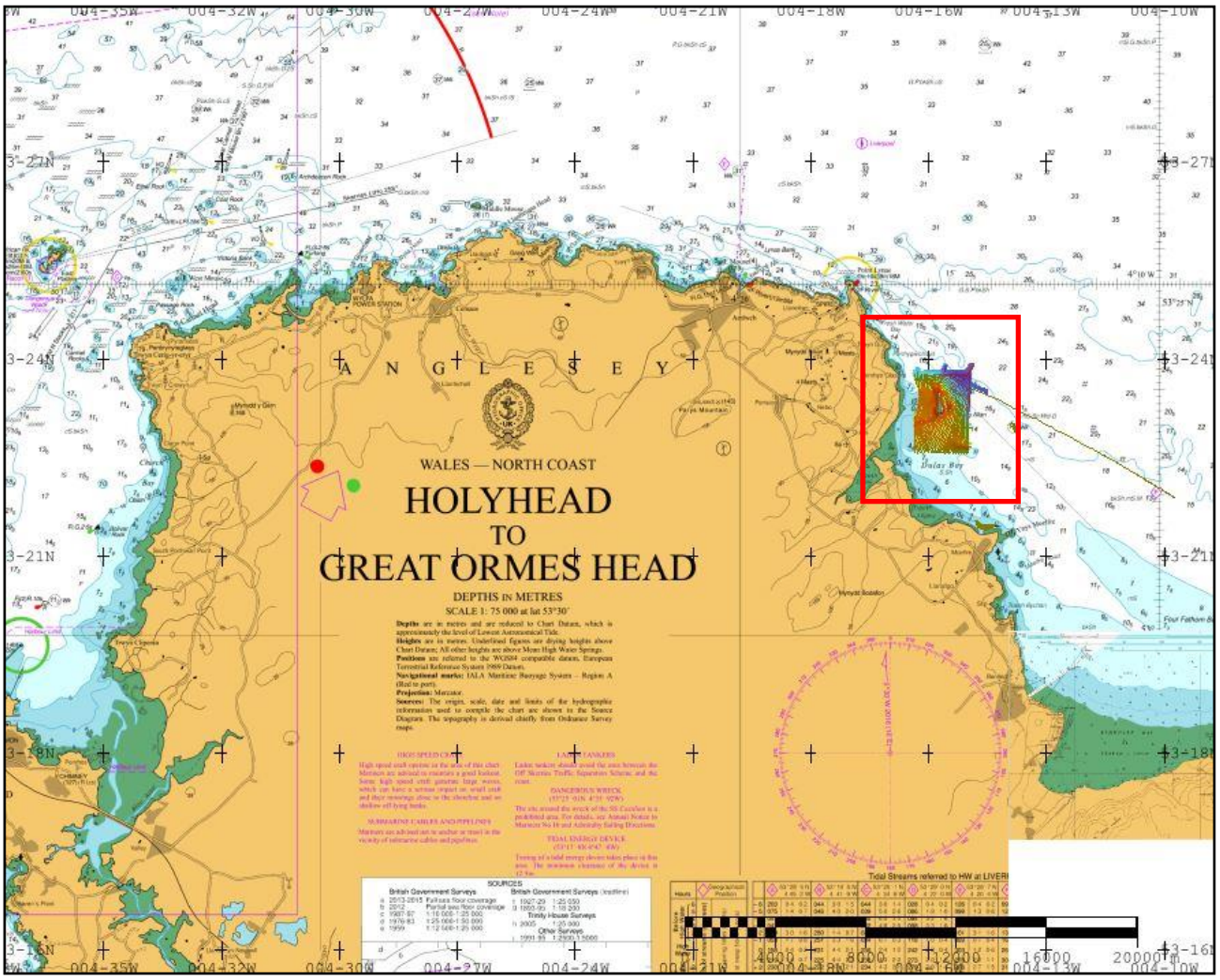

Figure 1 Overview location of survey block

Observation 01

Rock shoal extending from inside 5 m contour to outside the contour and rising to 2.2 m LAT observed. Entire length of shoal outside the 5 m contour is less than 5 m. Shoalest point outside 5 m contour occurs at 53-23-28.98 N 004-15-23.50 W. The location is to the north west of Garreg Allan shoal.

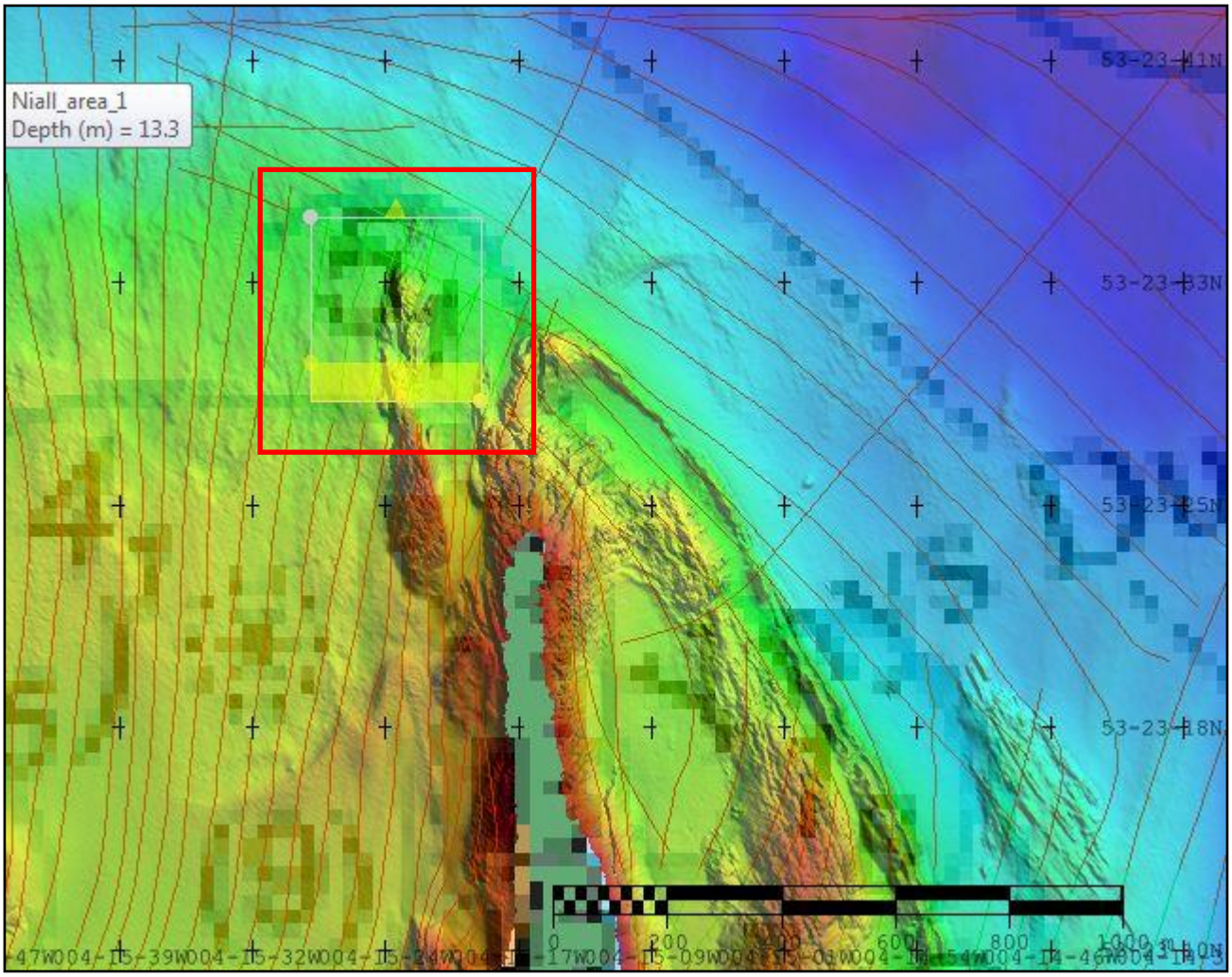

Figure 2 Zoomed image of shoal extending outside 5 m contour including subset box

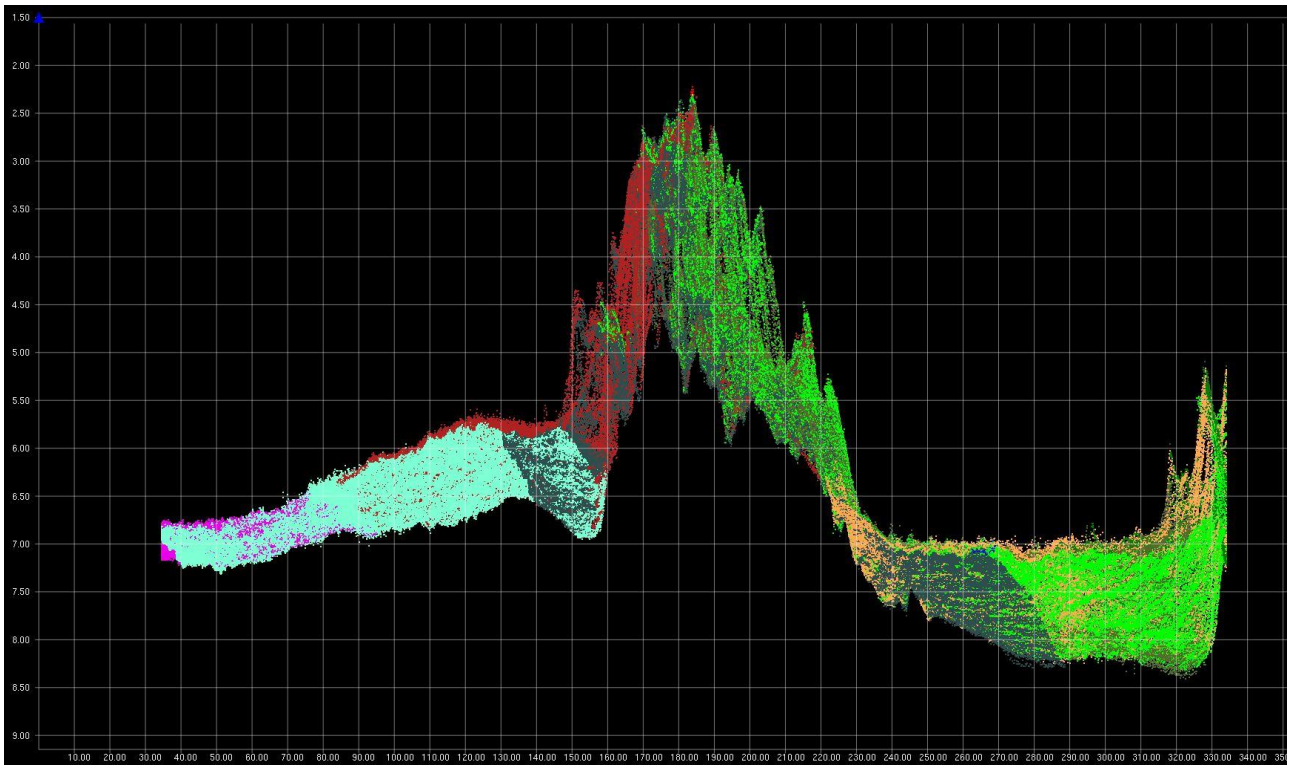

Figure 3 Subset view of shoal rising to 2.2 m LAT observed

Observation 02

The same rock shoal from observation 01 also rises to -1 m LAT observed inside 5 m contour. Occurs at 53-23-25.22 N 004-15-21.68 W. This shoal is also located to the north west of Garreg Allan shoal.

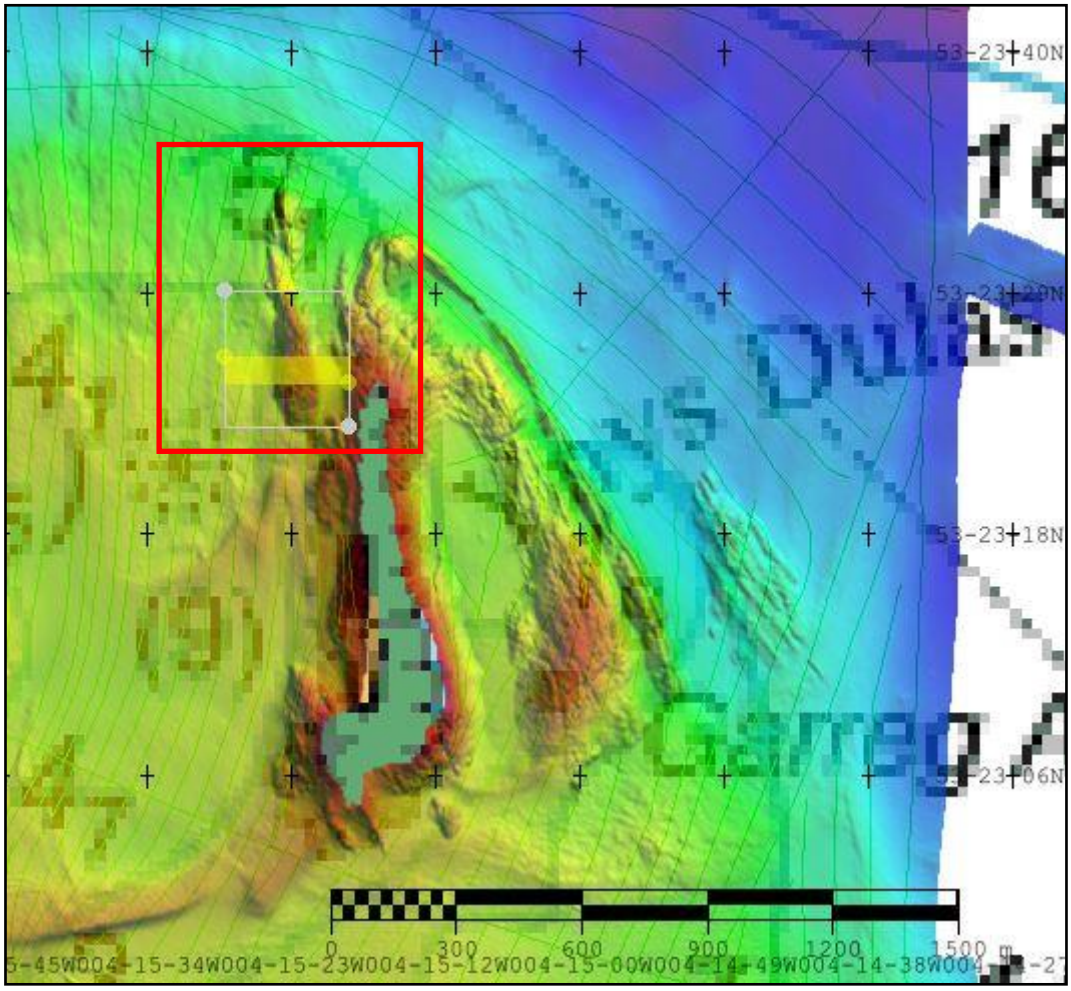

Figure 4 Zoomed in image of the shoal which rises to -1 m LAT inside the 5 m contour

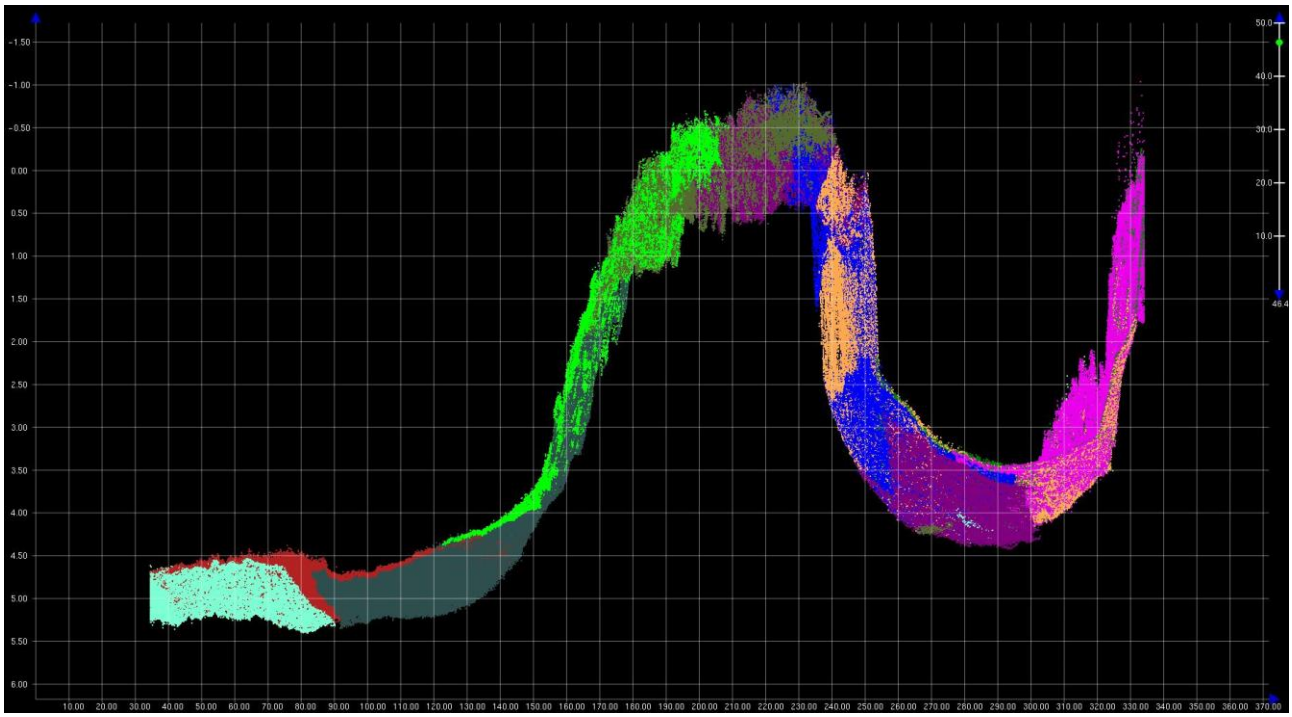

Figure 5 Subset view of the shoal rising to -1 m LAT observed

Observation 03

Roack shoal extending out from the northern tip of the Garreg Allan shoal rising to 1.7 m LAT observed. Occurs at 53-23-28.99 N 004-15-17.03 W. Nearest sounding on the chart is over 5 meters and the shoal is outside the 5 m contour.

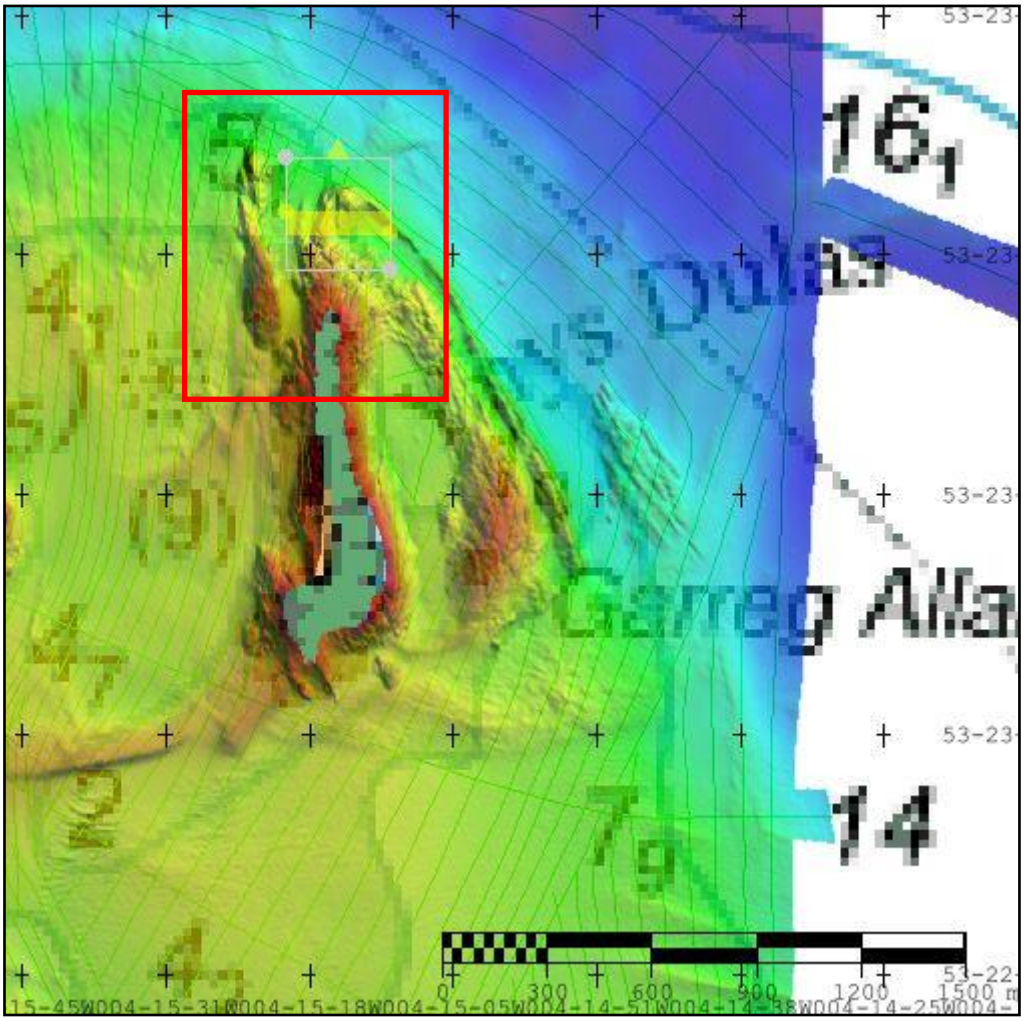

Figure 6 Zoomed in image of the shoal which rises to 1.7 m LAT observed

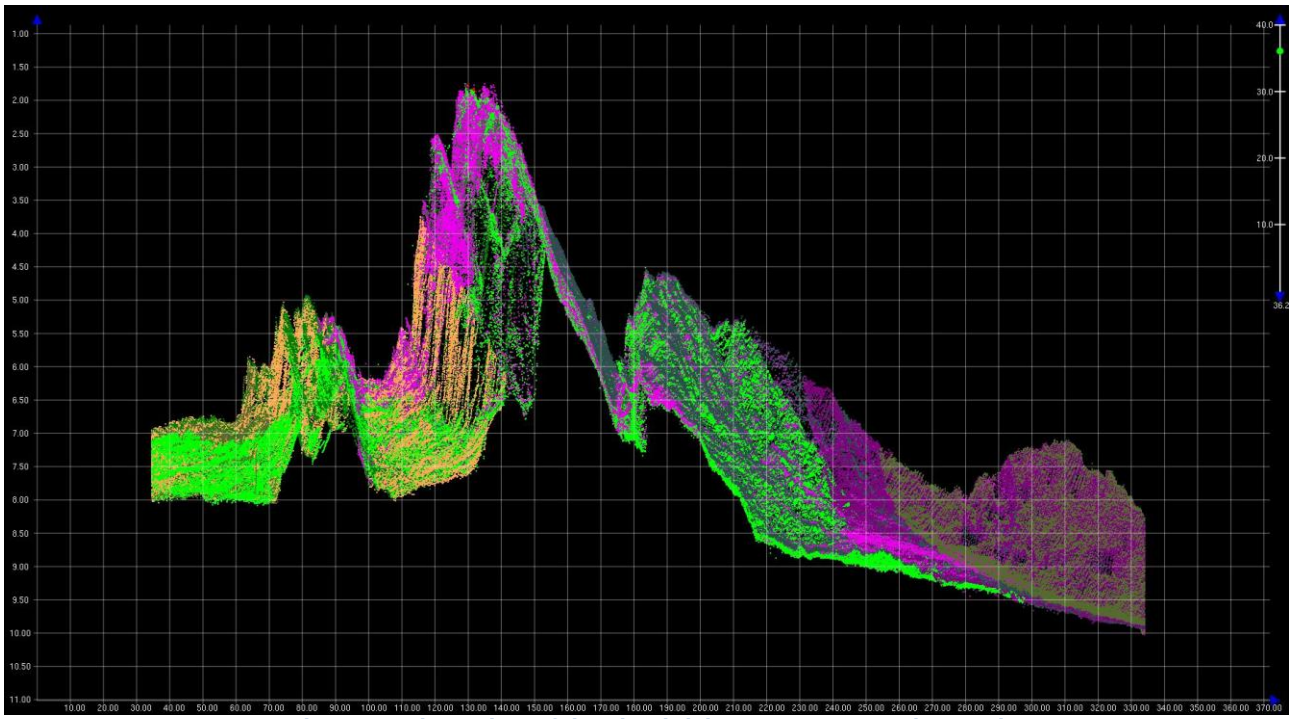

Figure 7 Subset view of the shoal rising to 1.7 m LAT observed

Observation 04

Rocky shoal marked on the chart as a drying area but the shoal is much larger than the chart shows. Shoal extends North of the drying mark on the chart and rises to -1 m LAT observed. Occurs at 53-23-13.66 N 004-14-59.68 W. This shoal is located east of the Garreg Allan shoal.

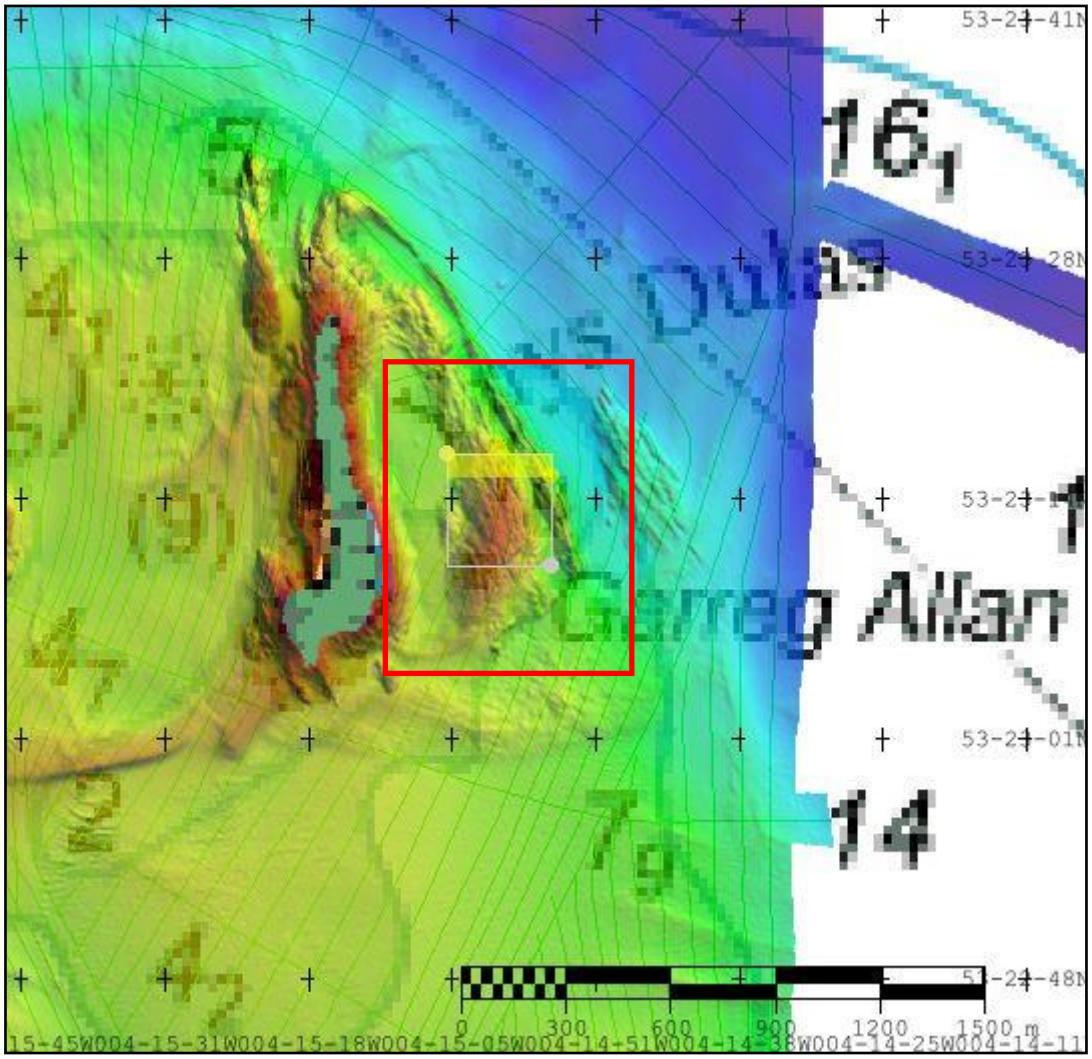

Figure 8 Zoomed in image of the shoal which rises to -1 m LAT observed

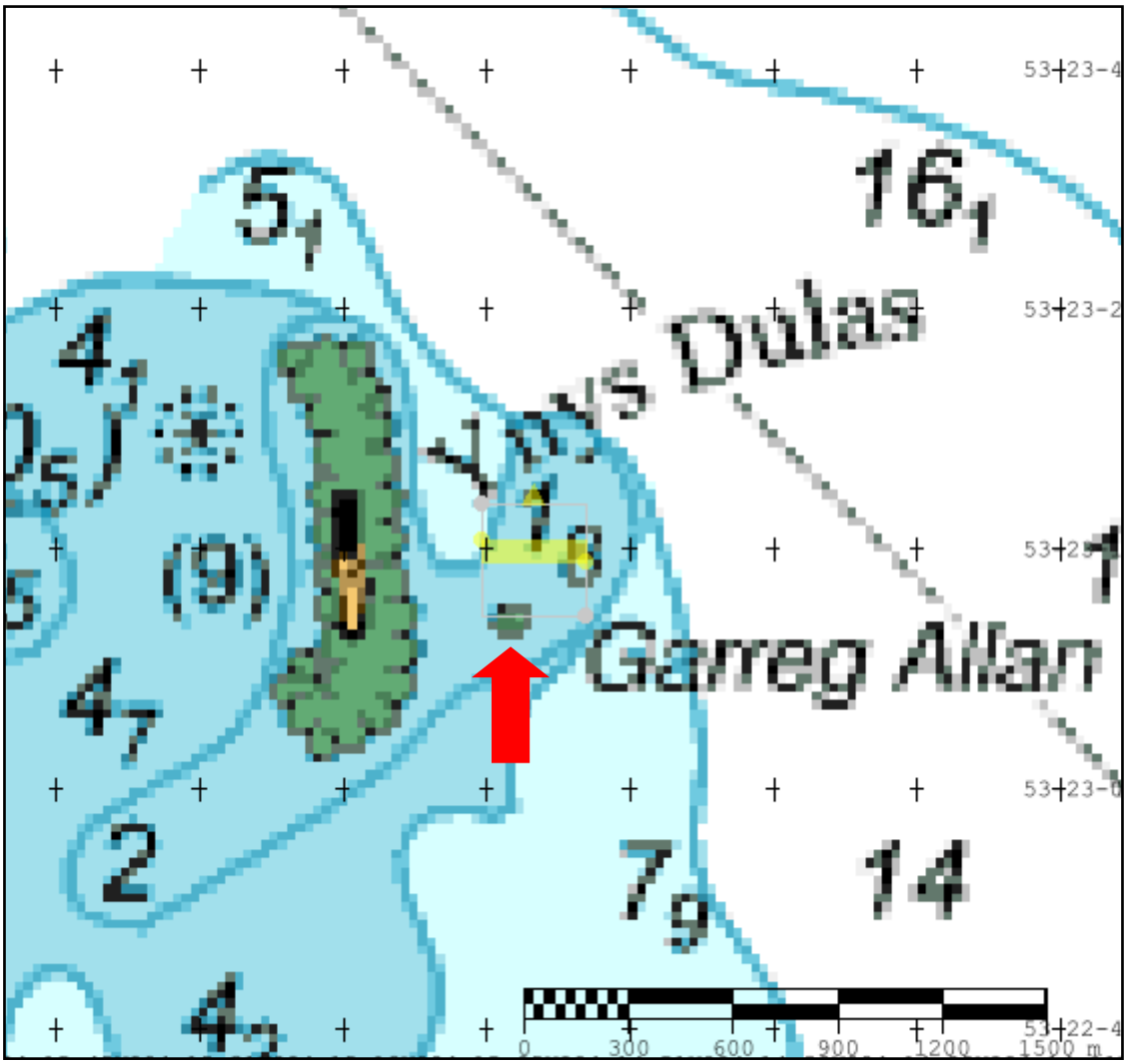

Figure 9 Chart details with red arrow pointing to drying area. Yellow rectangle of subset box shows location of shoal north of drying mark on chart

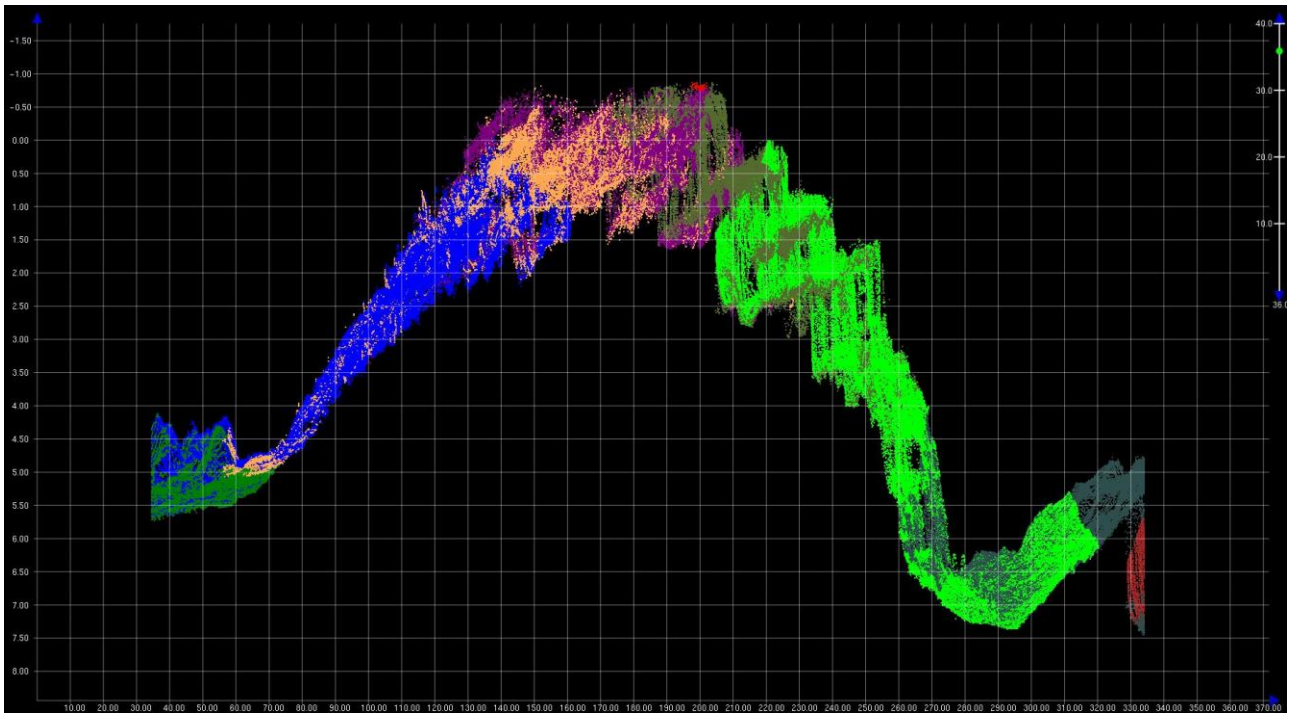

Figure 10 Subset view of the shoal rising to -1 m LAT observed

Observation 05

Sandbank rising to 1.3 m LAT observed. It appears the bank may have moved as there is a contour line south of the location of the sandbank. Occurs at 53-22-59.23 N 004-15-39.51 W. The sand bank is located south west of the Garreg Allan shoal.

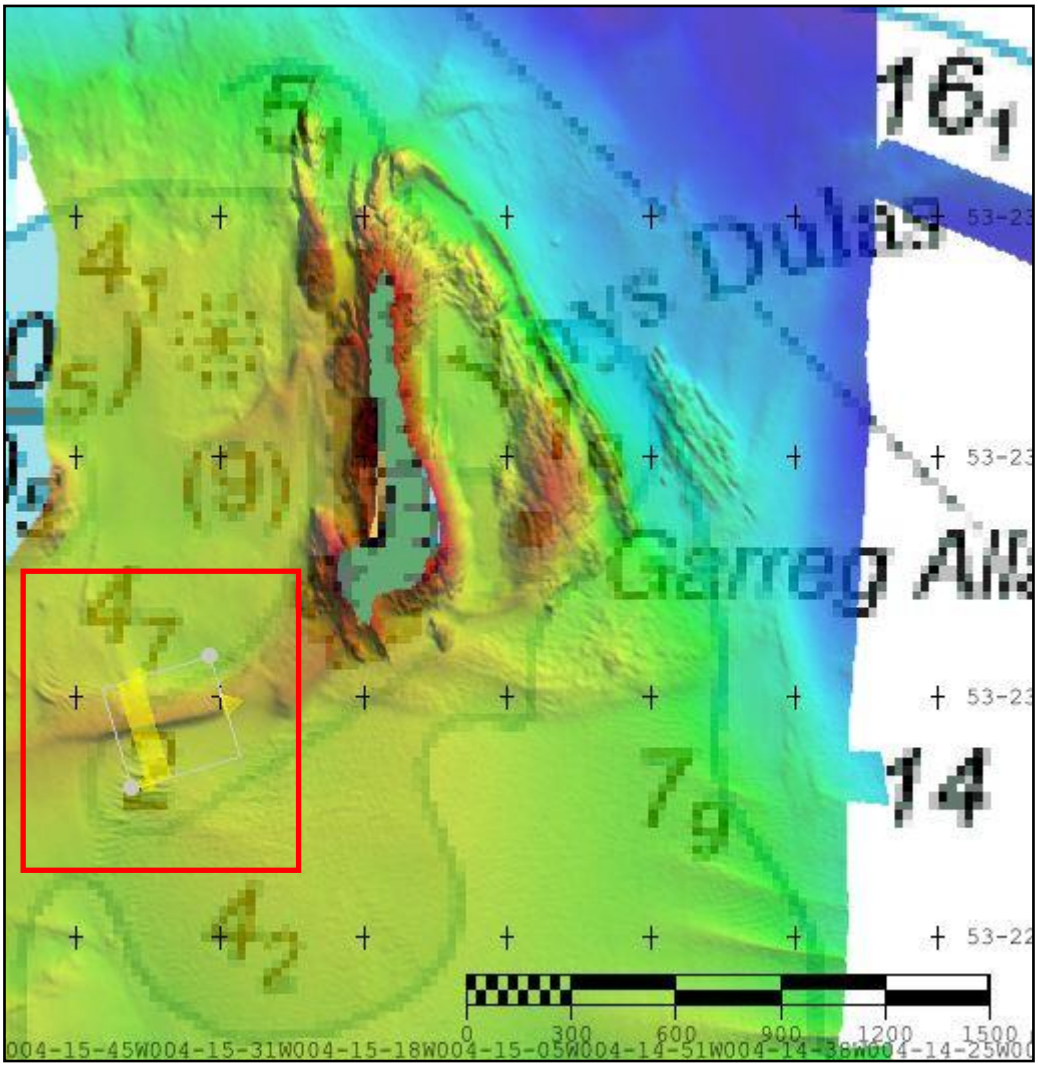

Figure 11 Zoomed in image of the shoal which rises to 1.3 m LAT observed

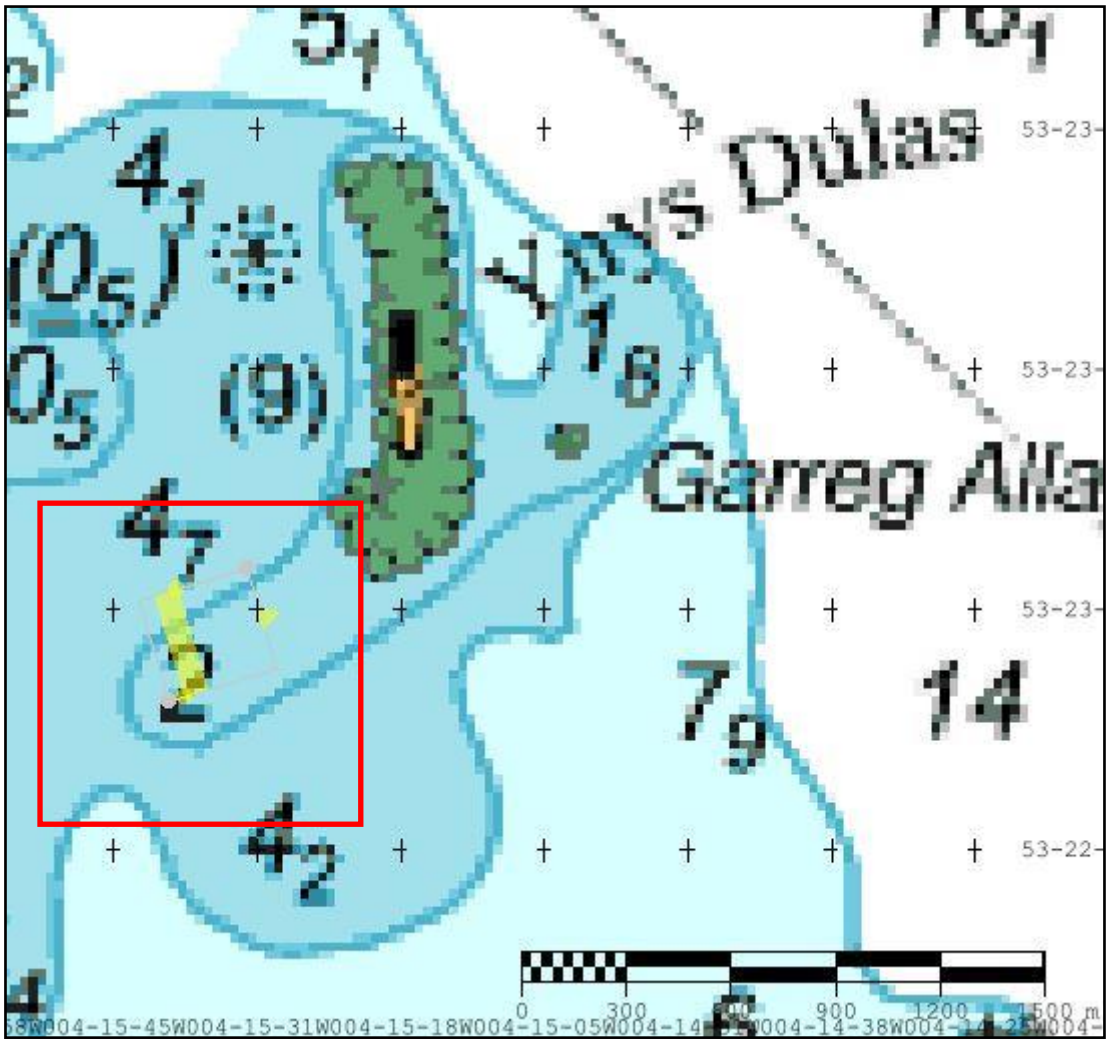

Figure 12 Chart details with red box showing rough location. Yellow rectangle of subset box shows exact location

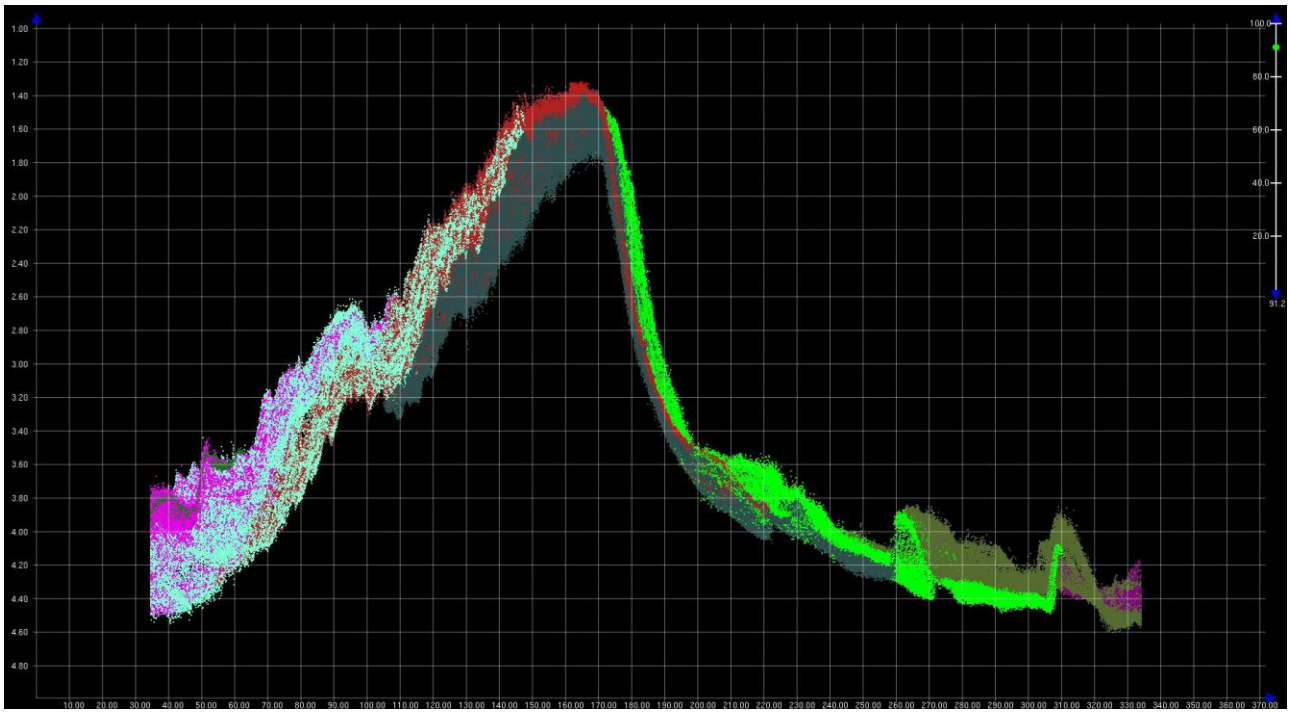

Figure 13 Subset view of the shoal rising to 1.3 m LAT observed

HYDROGRAPHIC NOTE

H.102
(V8.0 Oct 2014)

Date	19/09/2018		Ref. Number	H102-KRY18_03-002		
Name of ship or sender	Geological Survey of Ireland R.V. Keary					
IMO number if applicable	-					
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland					
E-mail/Tel/Fax of sender	inshore.infomar@gmail.com					
General Locality	Northern entrance to a Menai strait and part of Menai strait on western coast of Anglesey, Wales					
Subject	Multiple observations on area off the western coast of Anglesey, Wales					
Position *(see Instruction 2)*	Latitude	See following pages		Longitude	See following pages	
	GPS	POSpac -PPK	Datum	WGS 84	Accuracy	0.1m
Admiralty Charts affected	1977-0,1464-2,1464-3			Edition	Unknown	
Latest Weekly Edition of Notice to Mariners held	Unknown					
Replacement copy of Chart No *(see Instruction 3)*	**IS NOT** required					
ENCs affected						
Latest update disk applied	Week:					
Make, model and or age of ECDIS if applicable	Qinsy/Caris					
Publications affected (NP/DP number, Edition No.)	Unknown					
Date of latest supplement/update, page & Light List No. etc	Unknown					

Details of anomaly / observation:
Area surveyed as part of Irish-Wales CHERISH project. Observed depths differ from charted depths in a number of locations throughout the area surveyed. This data has not yet been finalised.

Data acquired by R.V. Keary:
- equipped with Kongsberg EM2040D and POSmv 320 Wavemaster. All depths are reduced to VORF LAT using GPStide methods. Navigation data is reprocessed using PP-RTX and transformed to ETRS89.

Name of observer/reporter	Niall Finn
H.102A Submitted No	H.102B Submitted No
Tick box if not willing to be named as source of this information	☐

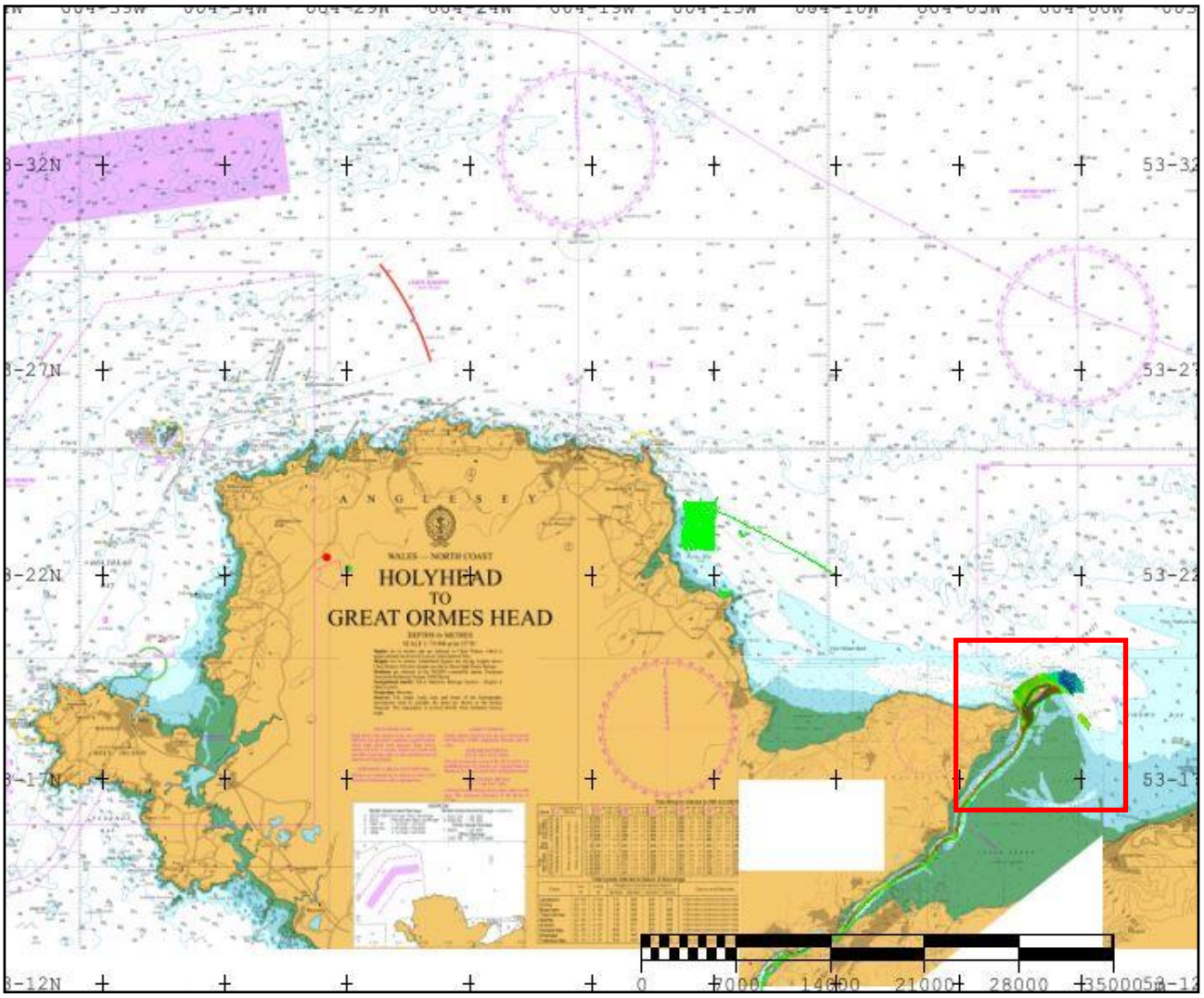

Figure 14 Anglsey with red square highlighting Menai strait where area containing observations for this H-Note are located

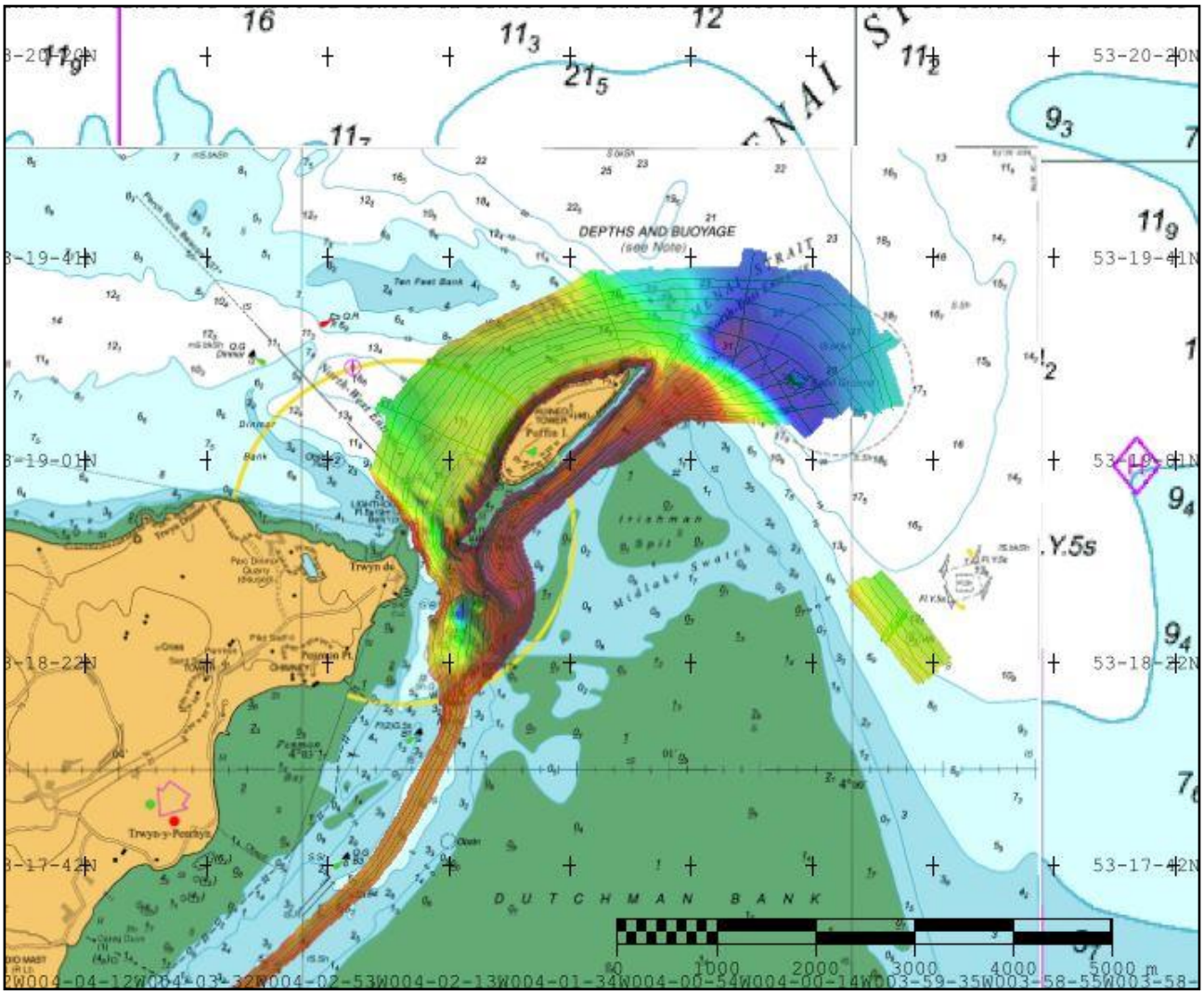

Figure 15 Zoomed in image showing Menai strait where observations from this H-note are located

Observation 01

Sand bank outside the 5 m contour and rising to 2.4 m LAT observed. Most of the area inside the red square between the 5m and 10 m contour rises to less than 5 m LAT observed. Occurs at 53-19-10.45 N 004-00-47.25 W.

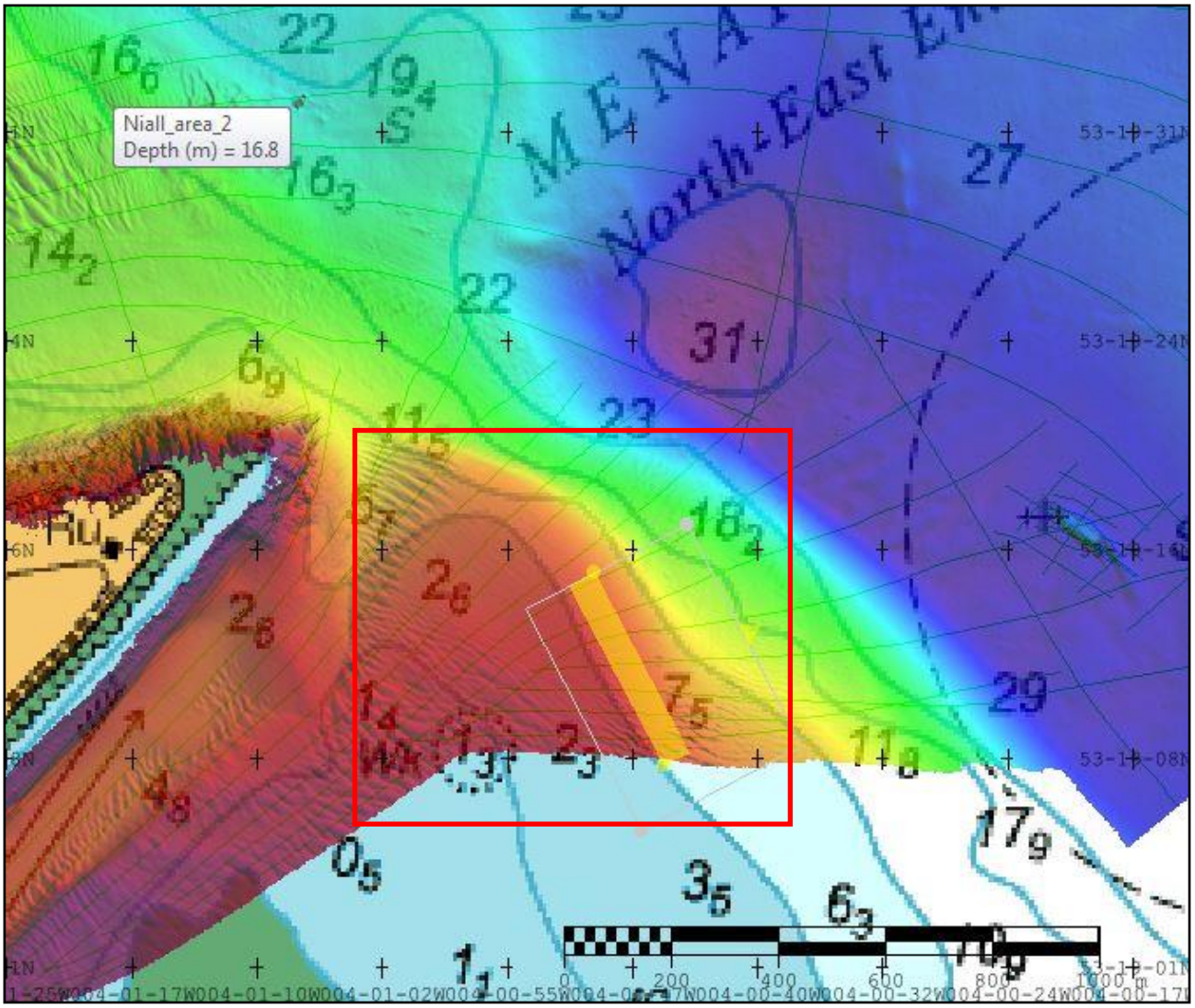

Figure 16 Sand bank rising to less than 5 m LAT observed in area between 5 m and 10 m contour with subset yellow rectangle

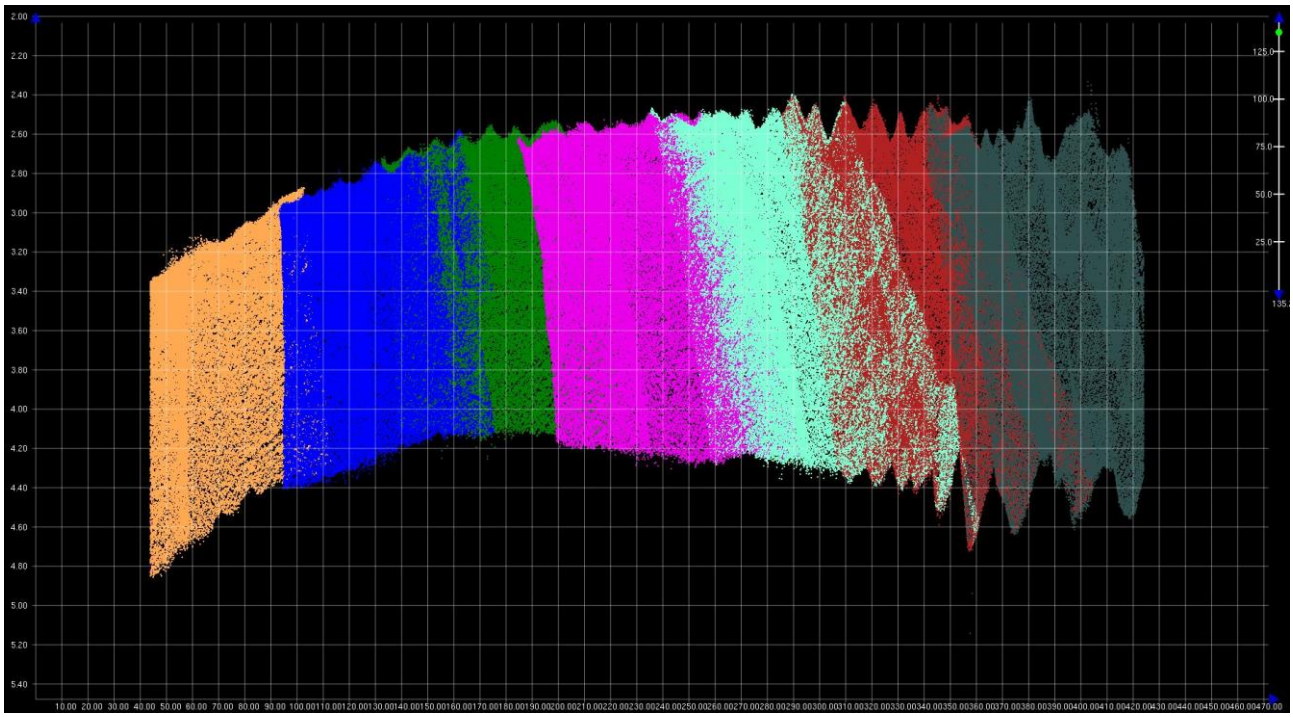

Figure 17 Subset view showing sandbank rising to 2.4 m LAT observed

Observation 02

Sand bank rising to -1 m LAT observed (drying) outside 1 m contour. There is a drying area marked on the chart south east of the sand bank so the bank may have moved. Shoalest point occurs at 53-19-00.29 N 004-01-23.72 W. The contour is incorrect all along the sand bank as I will illustrate with a series of images showing the subsets location and then the subset view.

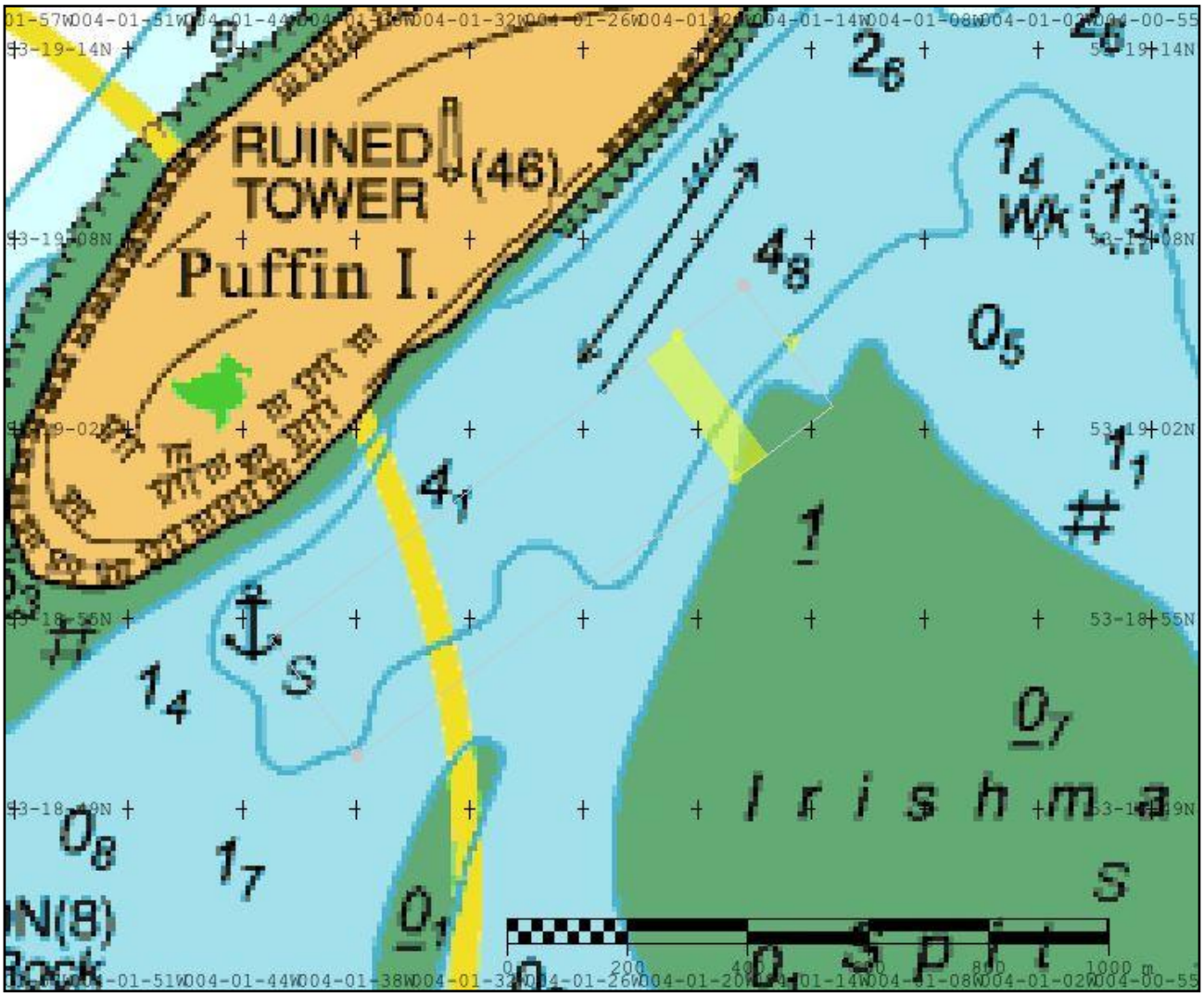

Figure 18 Image showing the chart details in the location of the sand bank and the incorrect contour

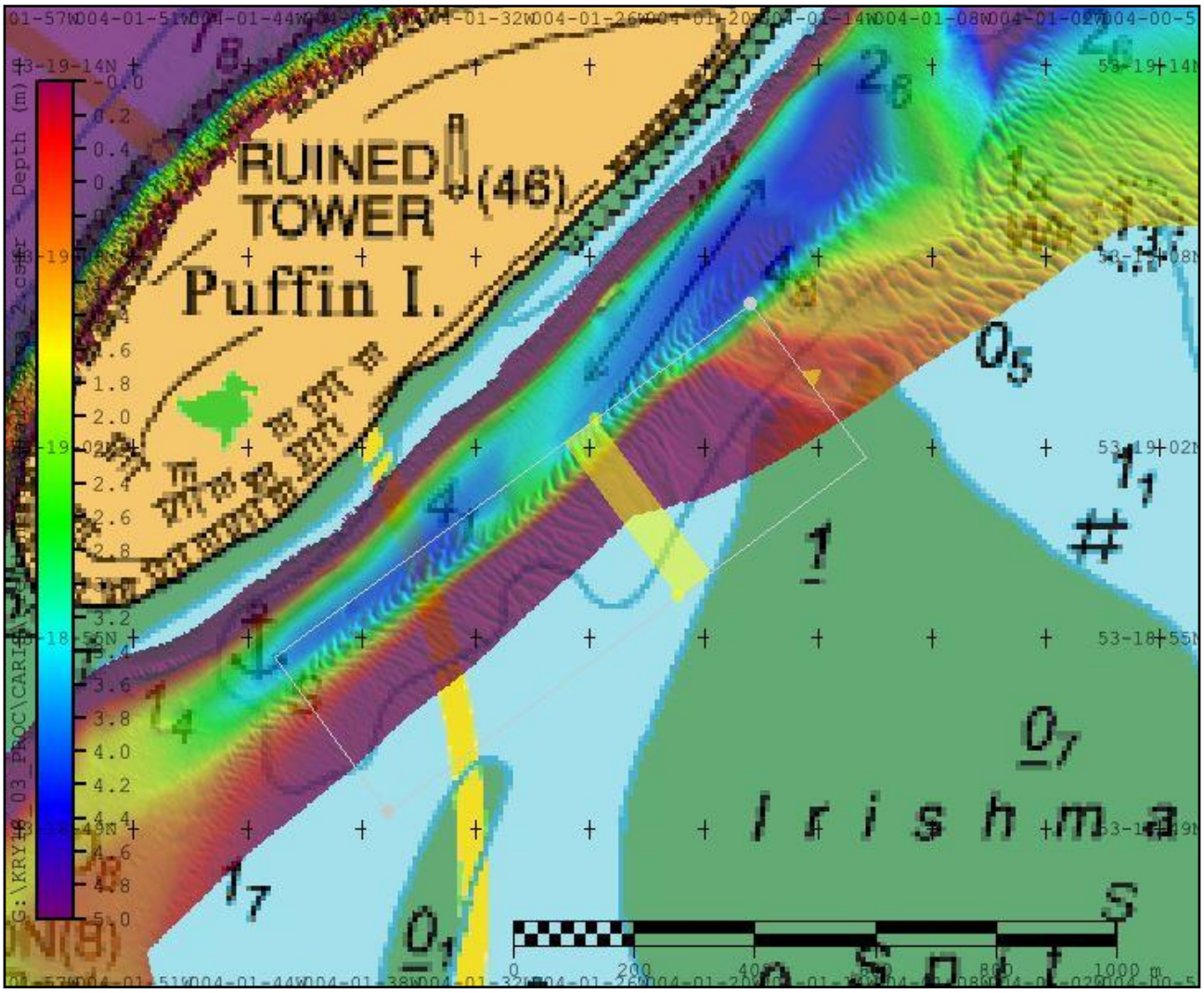

Figure 19 Sand bank that rises to -1 m LAT observed. Subset box is located on the shoalest point along the bank

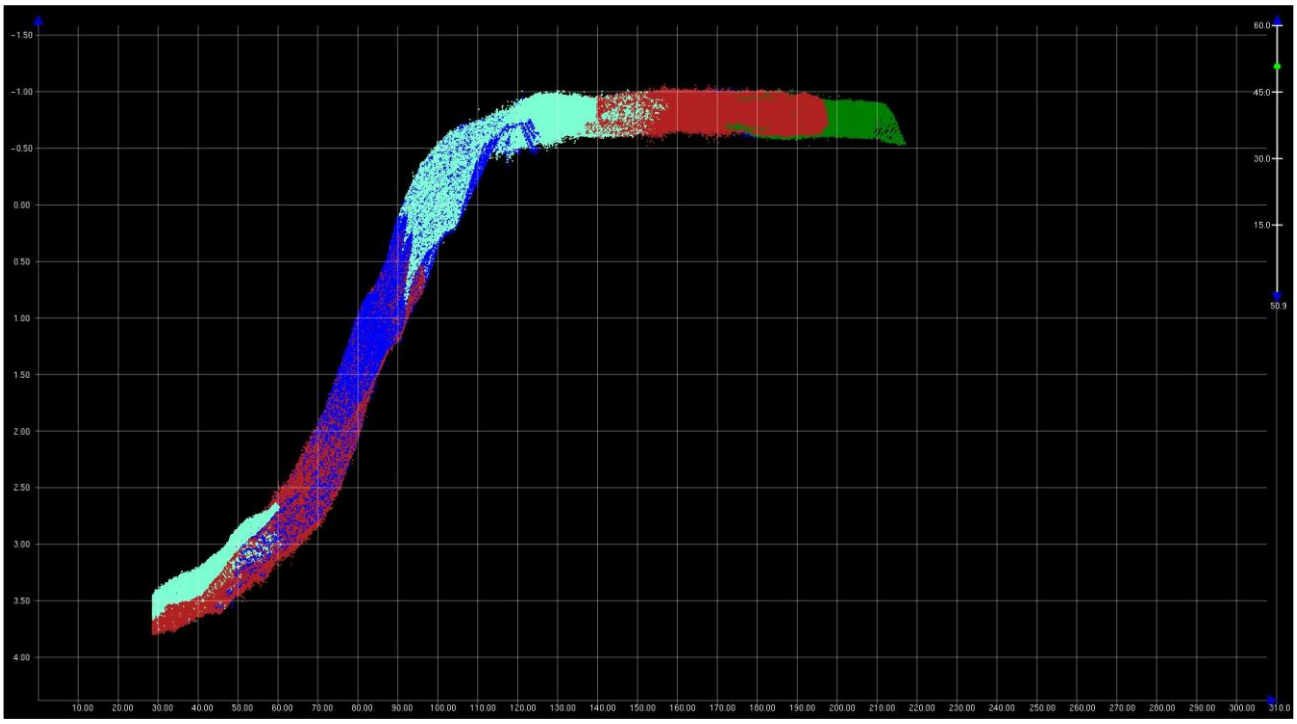

Figure 20 Subset view showing shoalest point along the sand bank

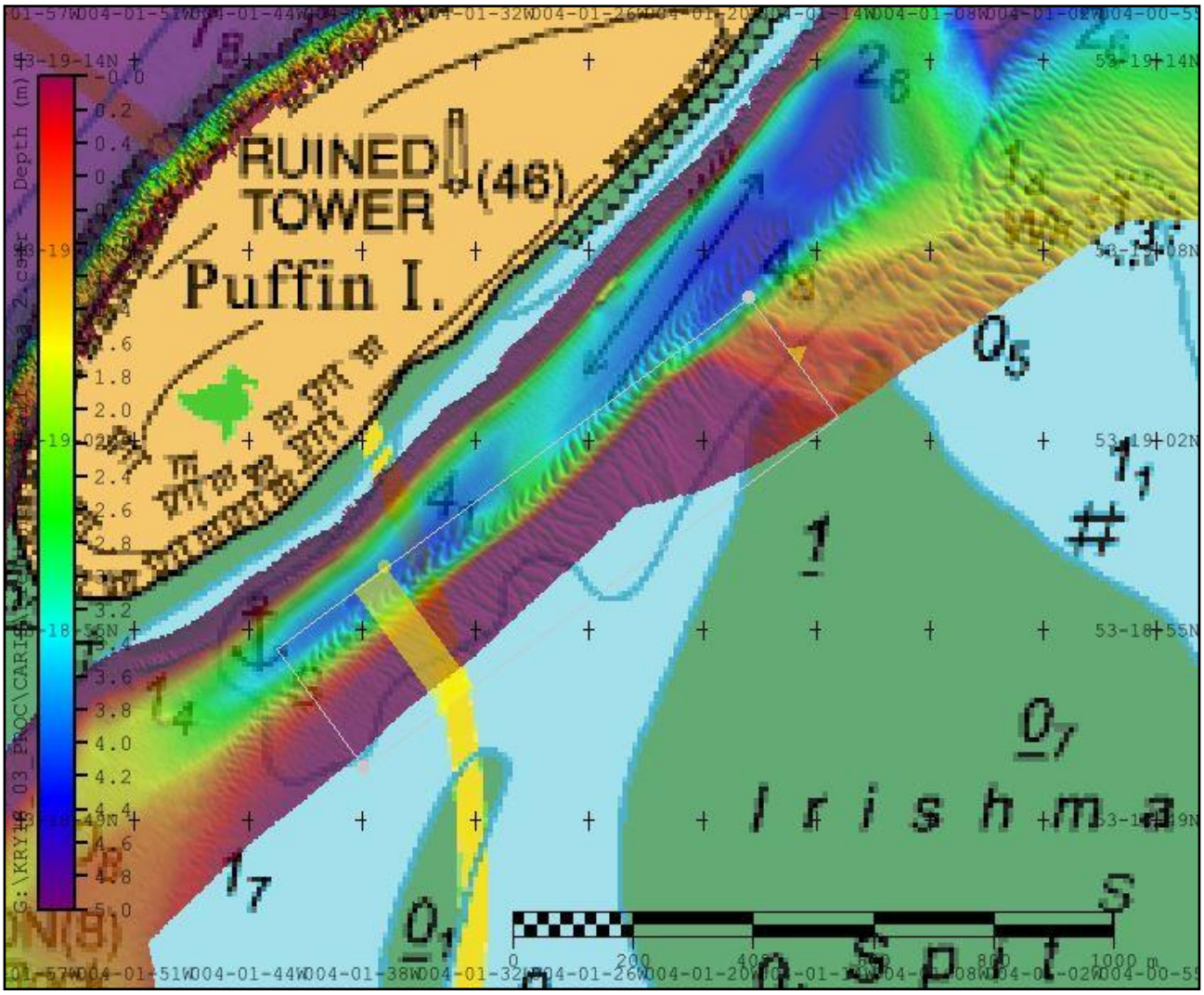

Figure 21 Another location along the sand bank which rises to -0.4 m LAT observed

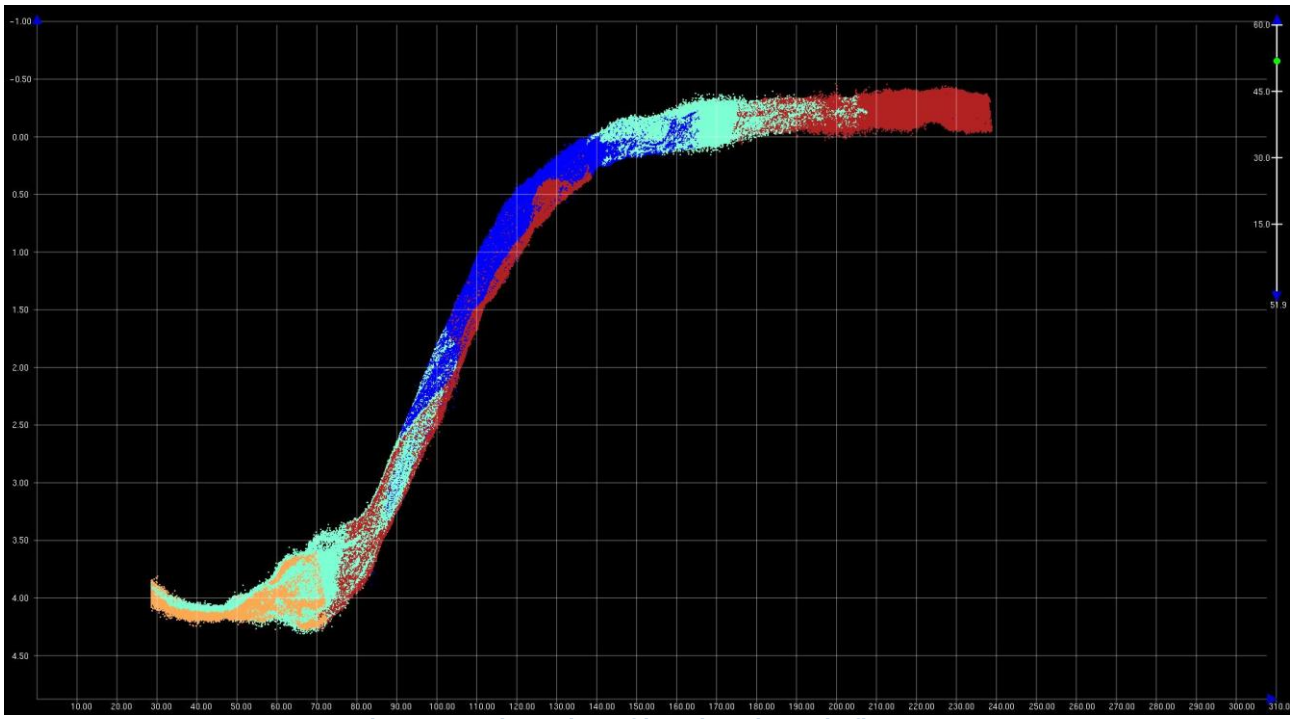

Figure 22 Subset view of location shown in figure 8

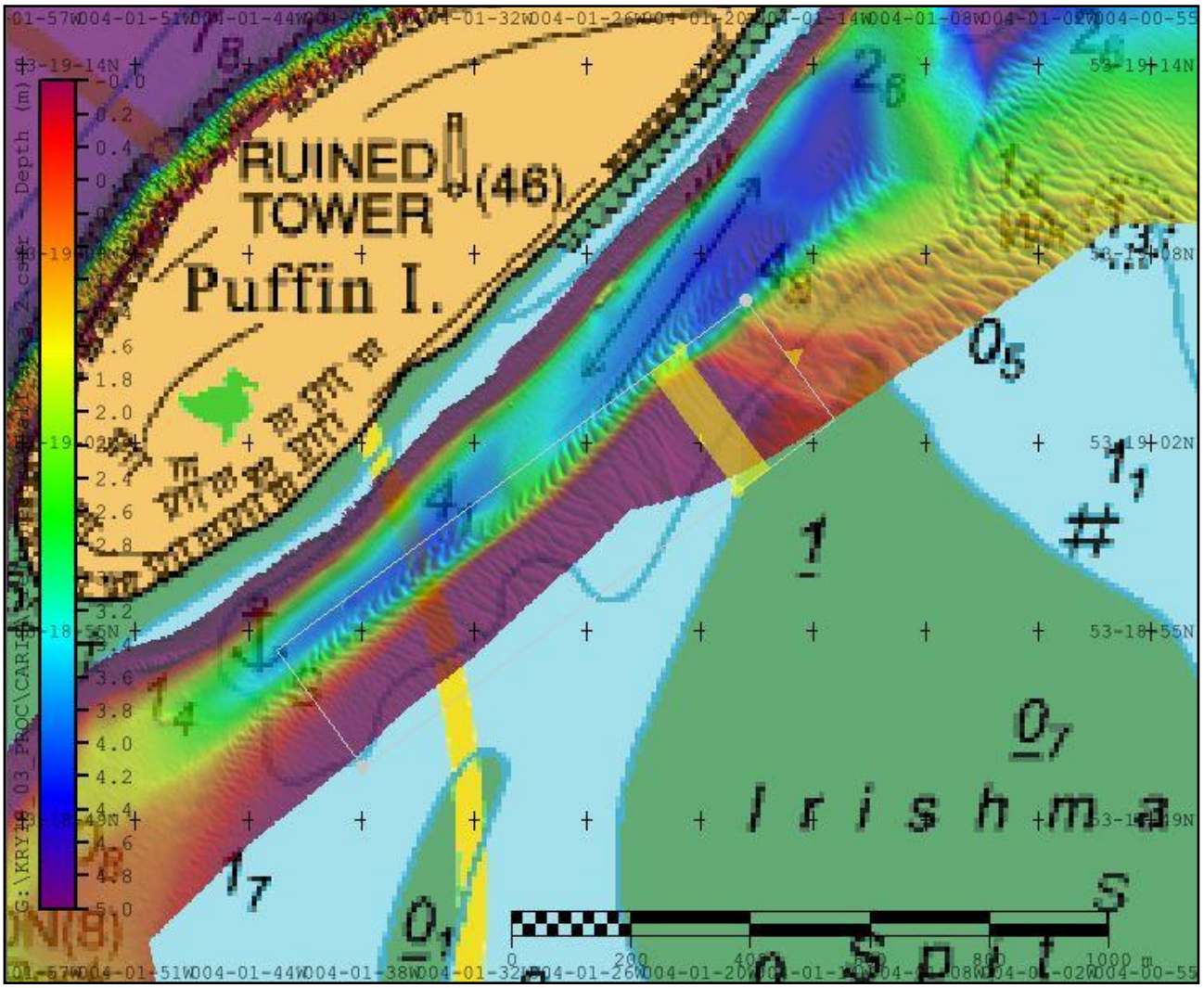

Figure 23 A third location on the bank which rises to -0.5 m LAT observed

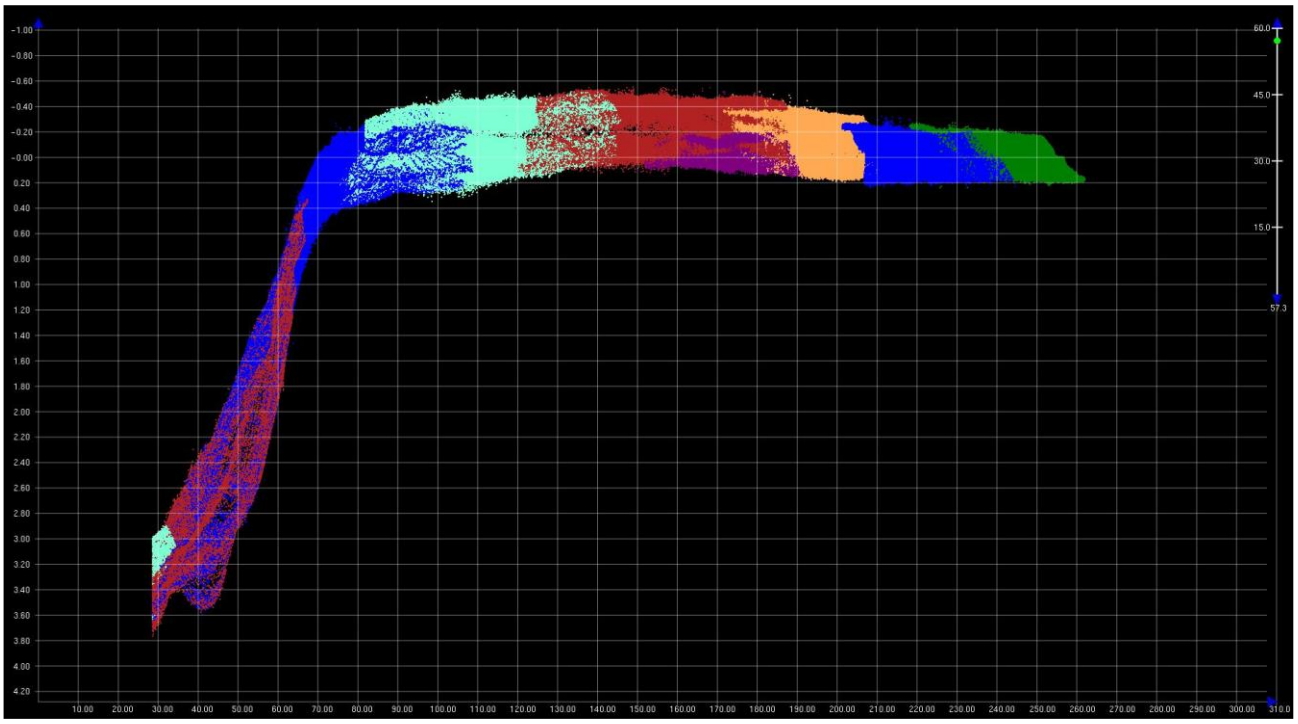

Figure 24 Subset view of location shown in figure 10

Observation 03

This shoal rises to 10.6 m LAT observed. The contours are not incorrect but I thought it was worth including as it rises to 10.6 m LAT in an area of 13 m LAT. It occurs at 53-18-53.50 N 004-02-20.91 W. There is a sounding of 10$_9$ south east of the shoal and maybe this should be closer to the shoal.

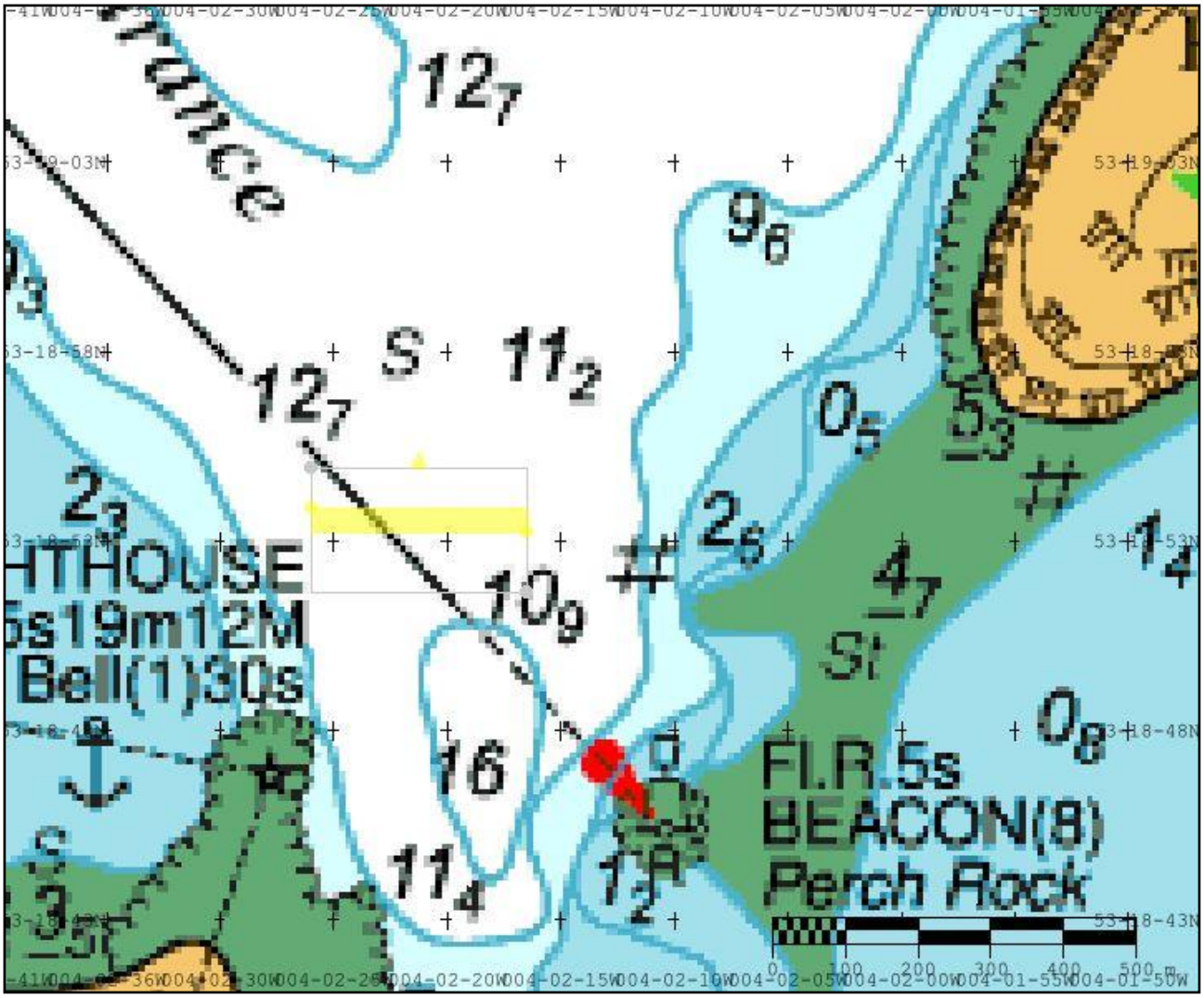

Figure 25 Image showing the chart detail in the are and the subset box with the yellow rectangle over the location of the shoal

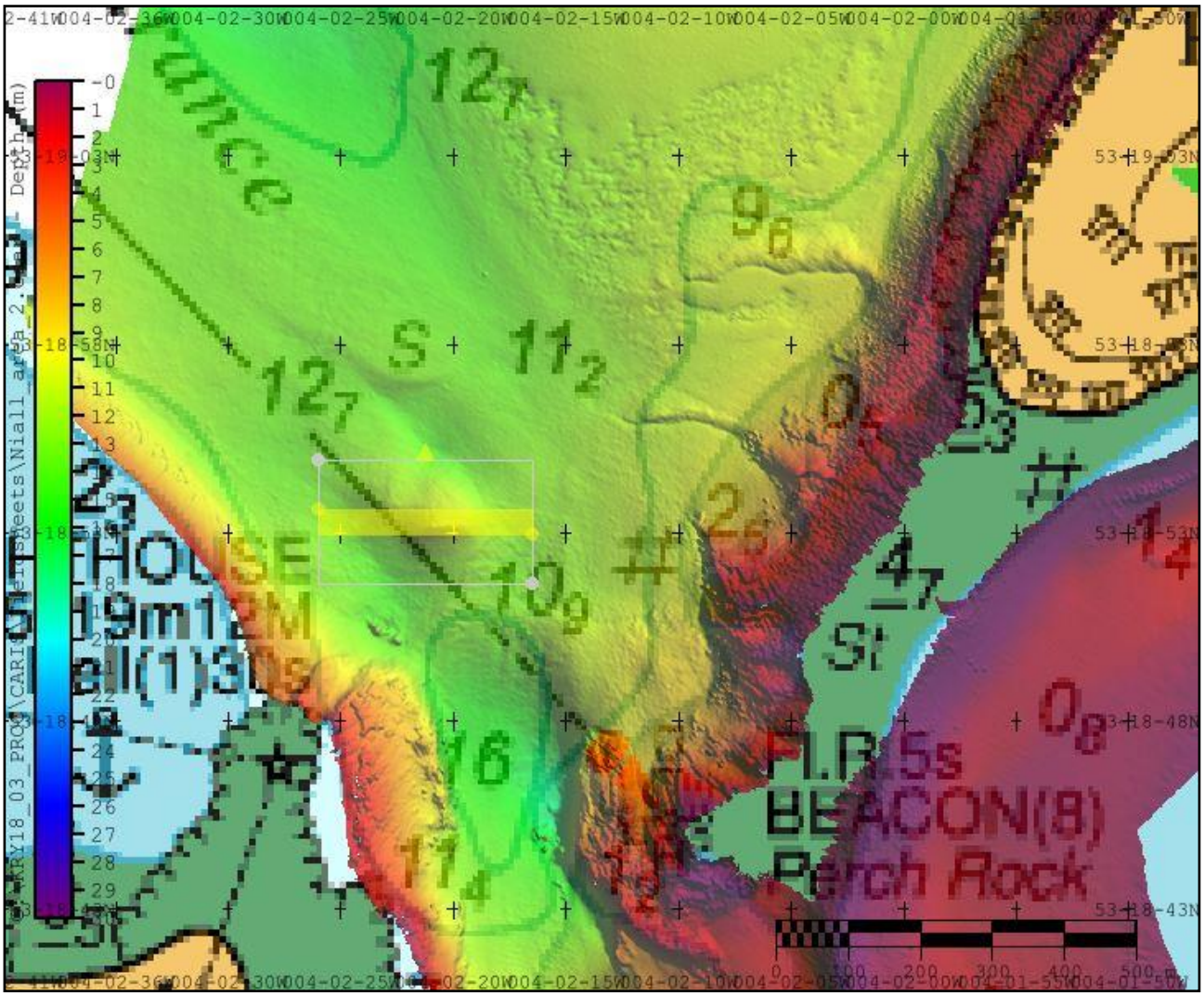

Figure 26 Image showing the shoal and with the subset yellow rectangle over it

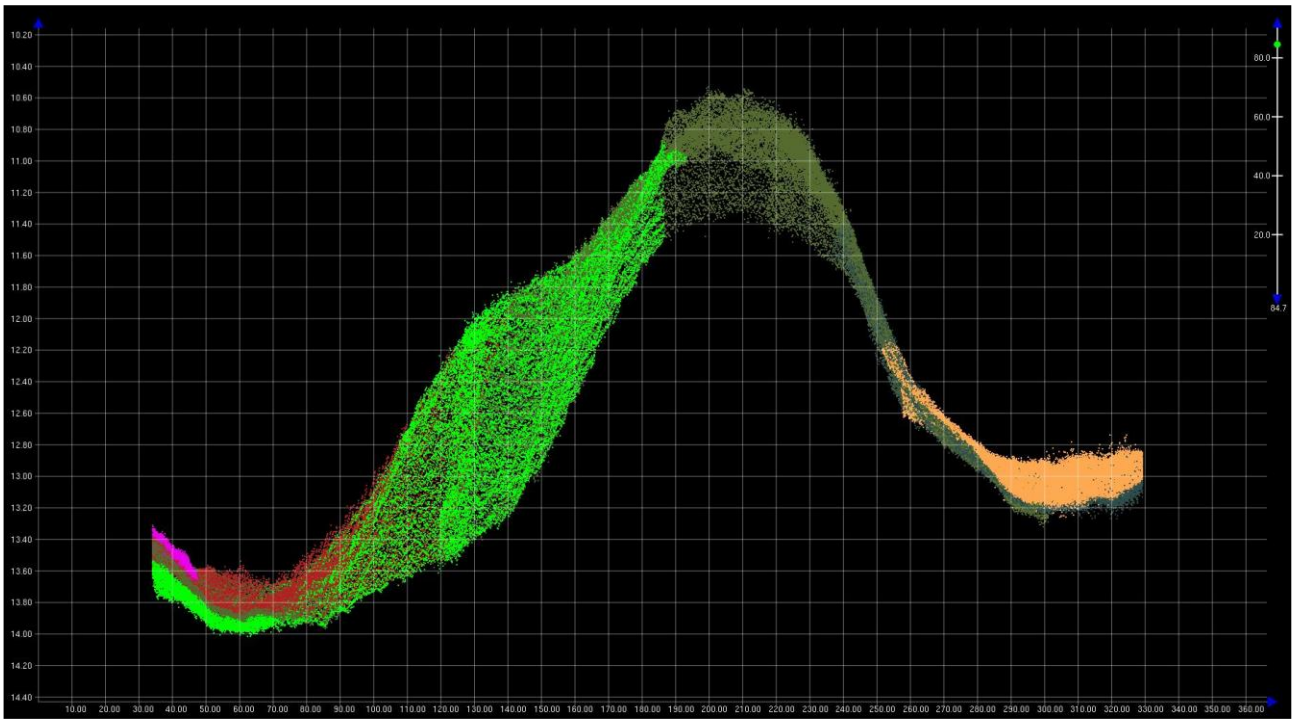

Figure 27 Subset view of the shoal

Observation 04

Rocky shoal rising to 7.3 m LAT observed outside the 10 m contour and very close to the 15 m contour. Occurs at 53-18-47.65 N 004-02-21.82 W. The entire length of the shoal rises to less than 10 meters.

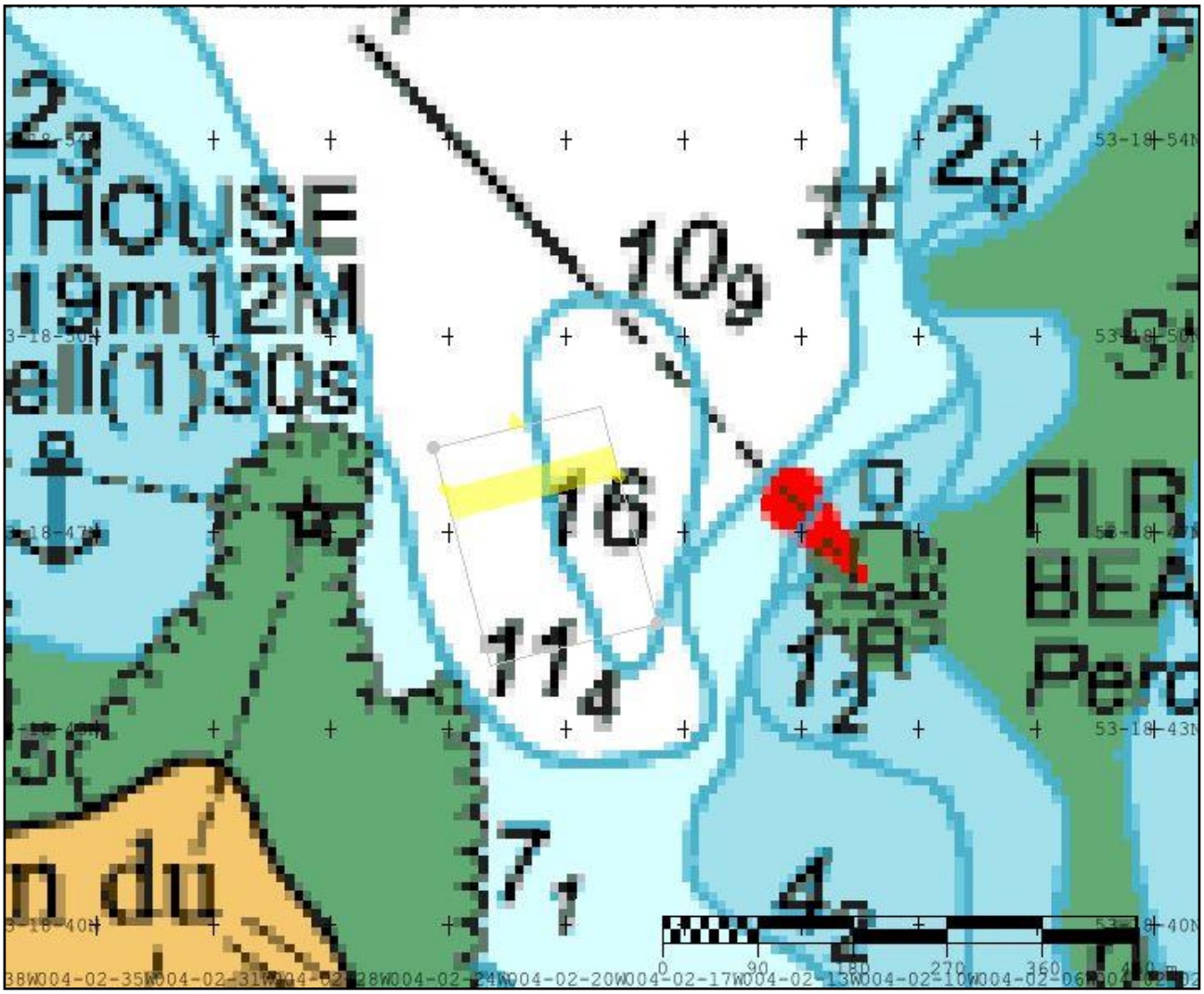

Figure 28 Image showing chart details around the rocky shoal which is in the yellow rectangle of the subset

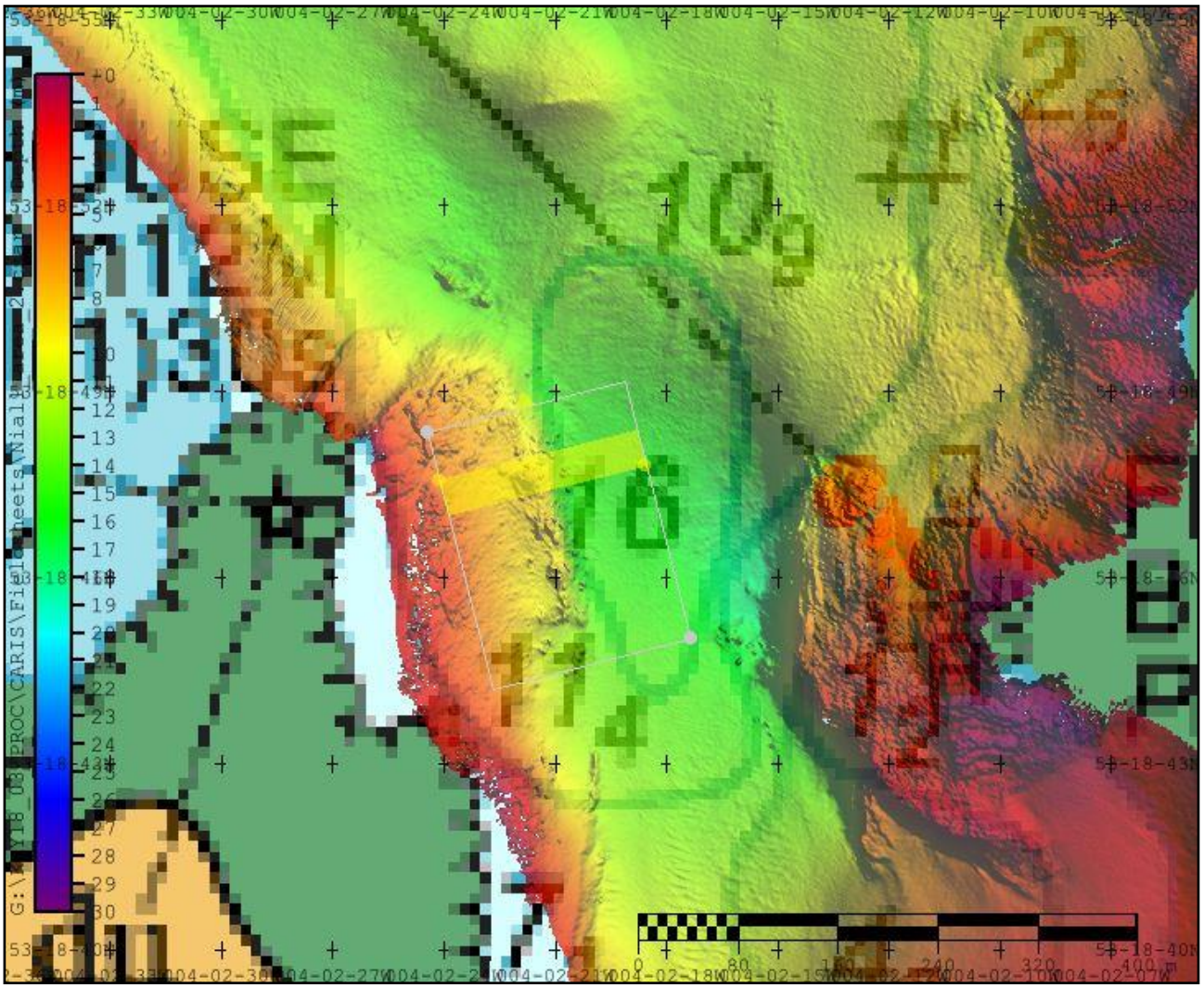

Figure 29 Image showing the rocky shoal which rises to 7.3 m LAT observed

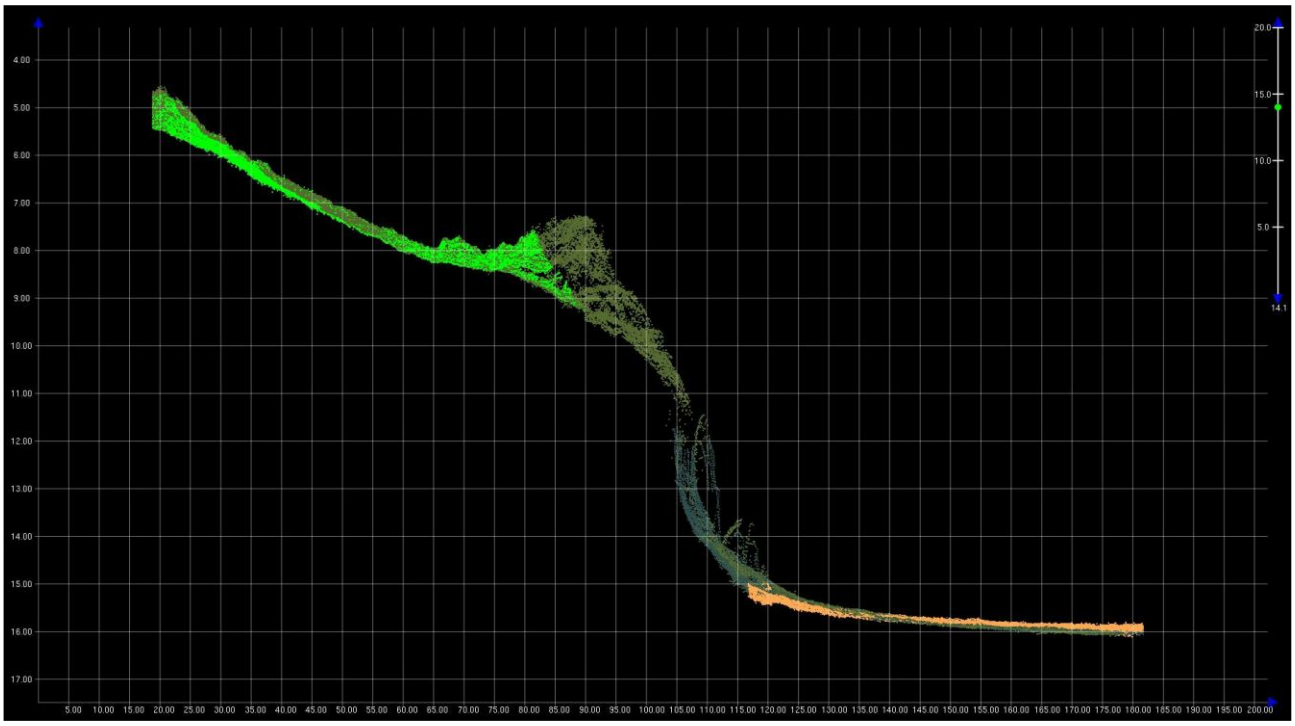

Figure 30 Subset view showing the shoal rising to 7.3 m LAT observed

Observation 05

Sand bank rising to -0.2 m LAT observed on an area where the chart reads 14. The sounding on the chart is located between two areas marked as drying areas on the chart. Occurs at 53-18-32.63 N 004-01-53.19 W.

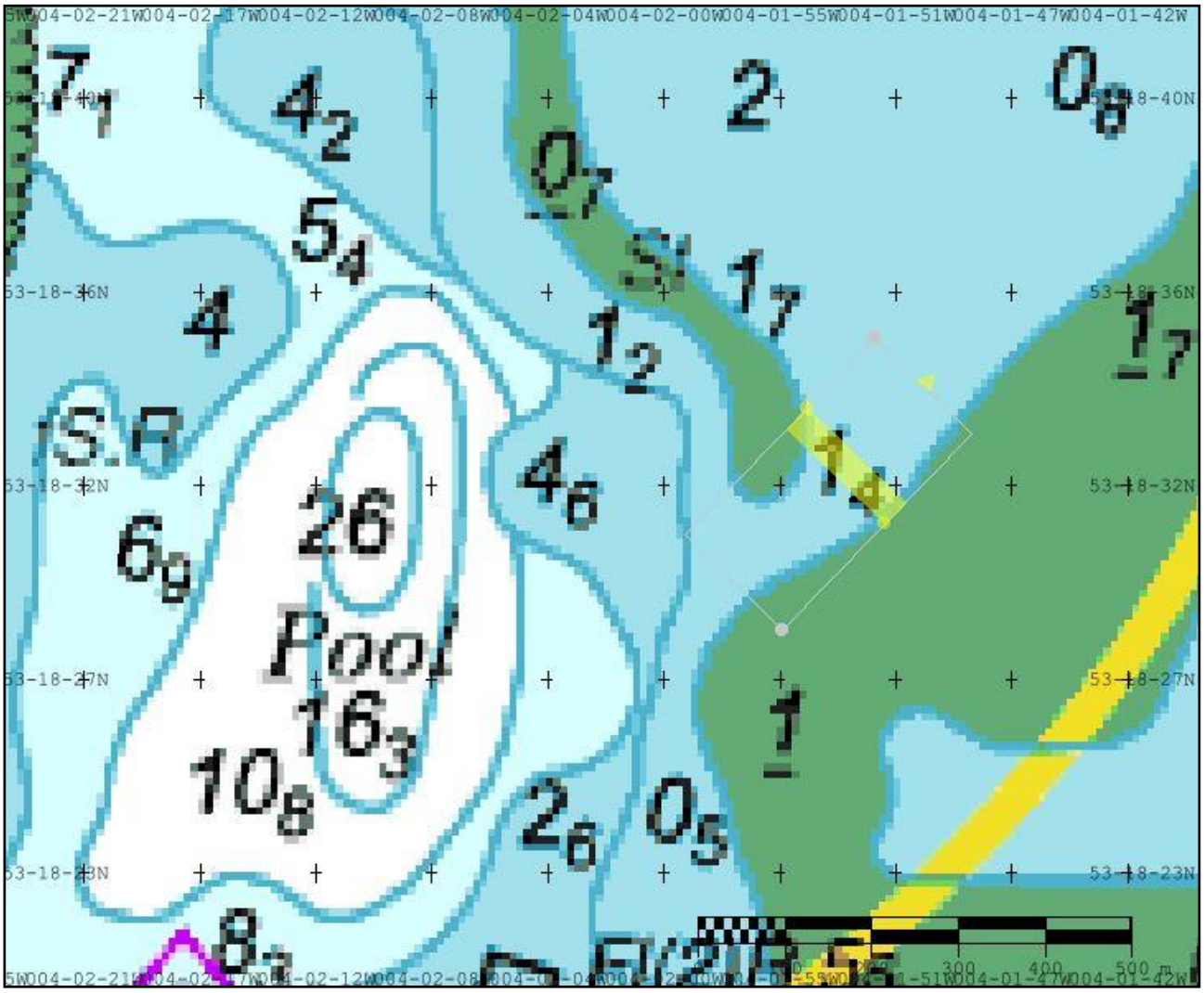

Figure 31 Chart details showing the 14 sounding in the subset yellow rectangle and between the two drying areas

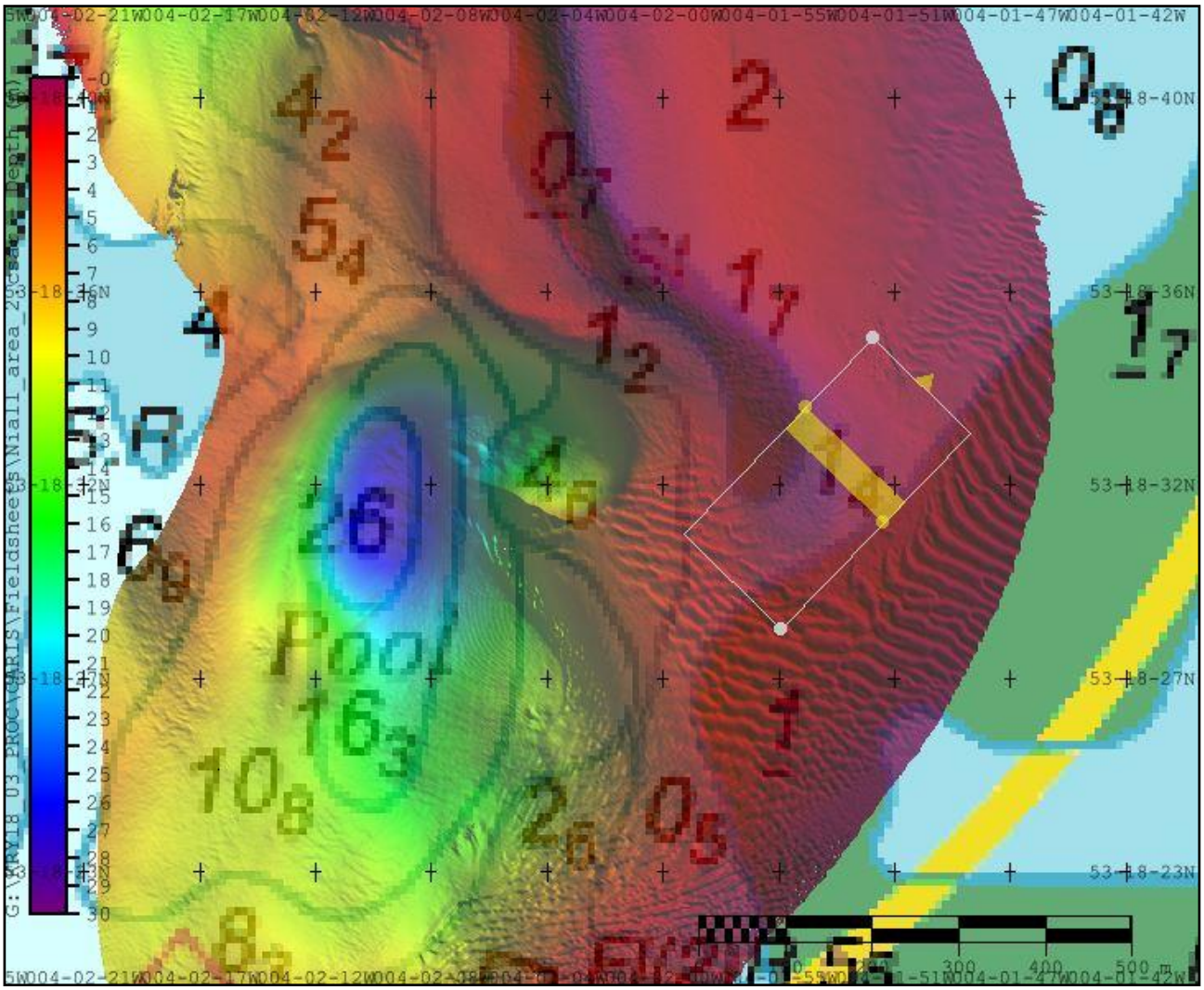

Figure 32 Image showing the sand bank over the 14 sounding

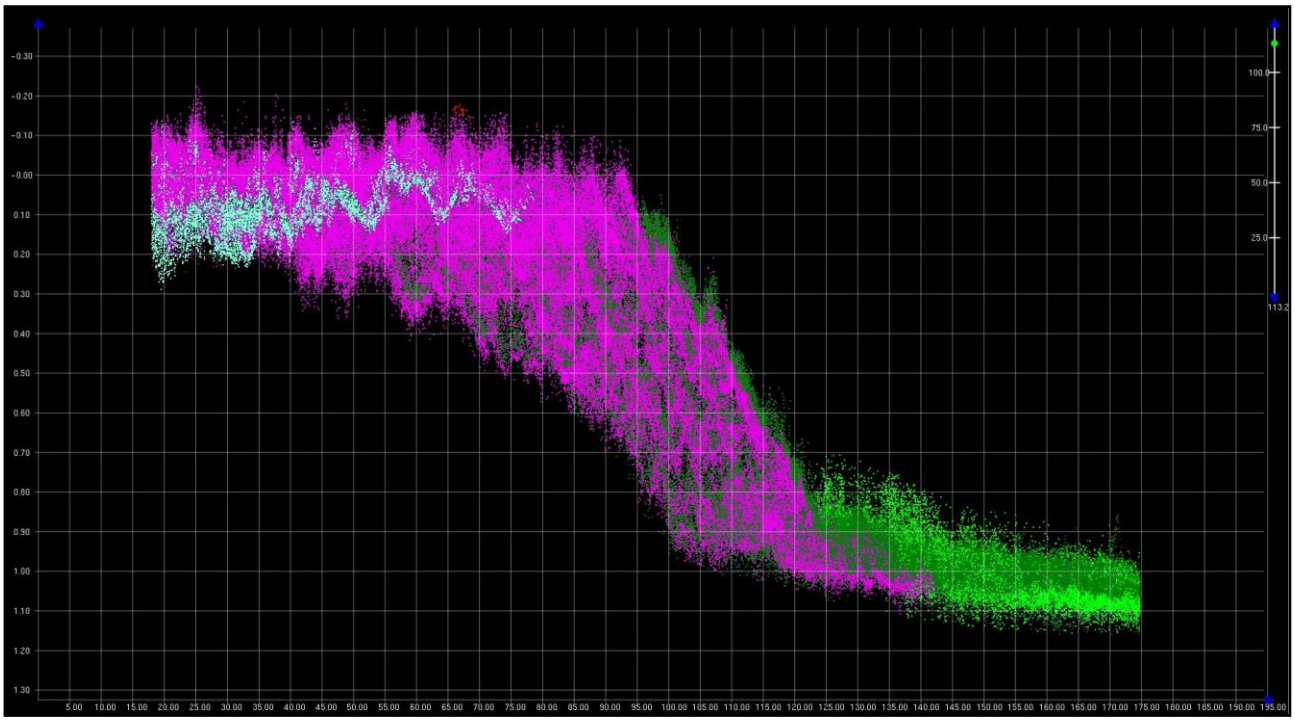

Figure 33 Subset view showing the sand bank at -0.2 m LAT observed

Observation 06

Sand wave rising to 2.3 m LAT observed outside 5 m contour. Occurs at 53-18-17.39 N 004-02-08.76 W. This is the location of the shoalest point and this is very close to the contour line. However, most of the area bounded by the 5 m contour, which you will see in the images, is less than 5 m LAT.

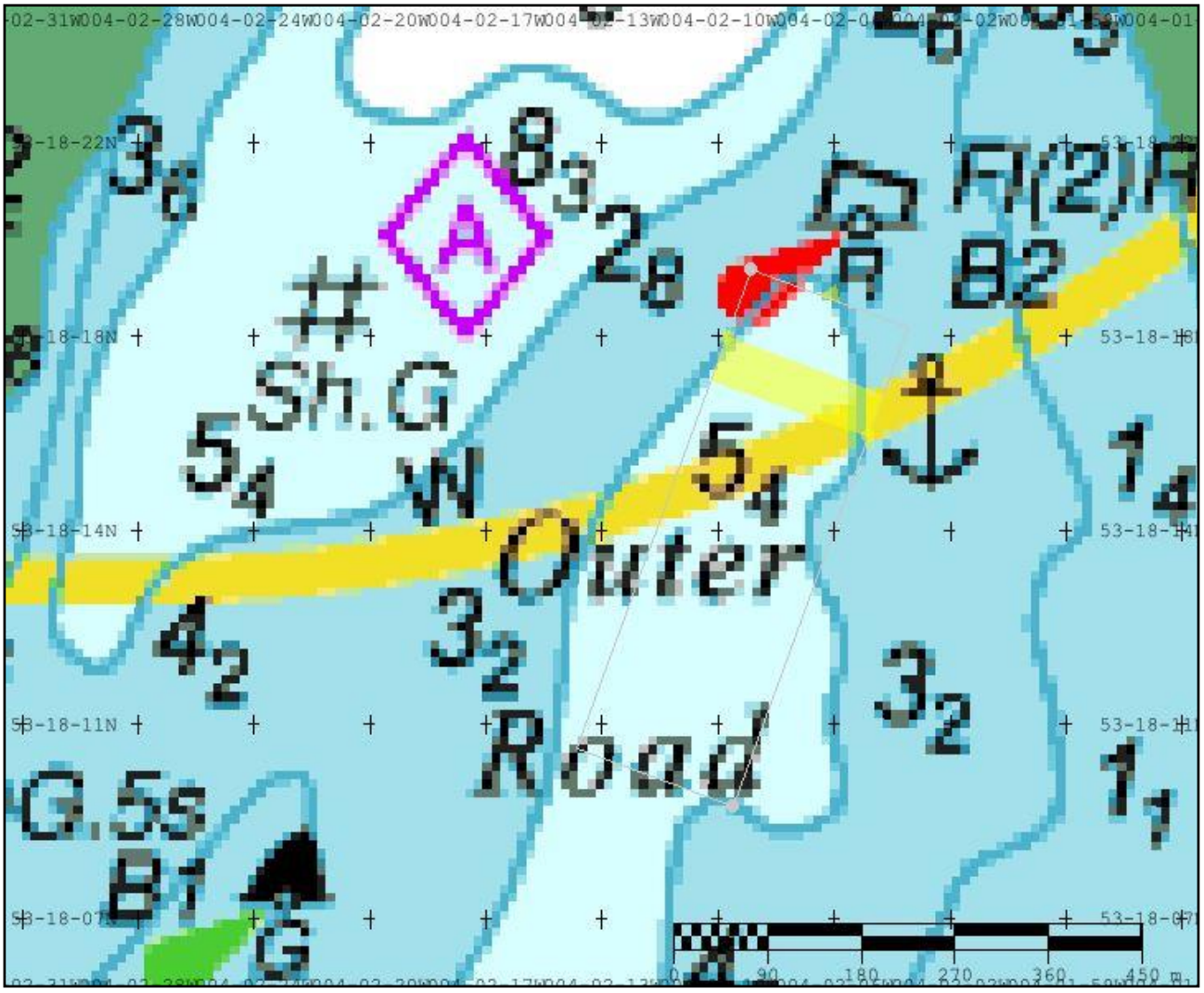

Figure 34 Chart details showing the area bounded by the 5 m contour with the subset rectangle showing the location of the shoalest point

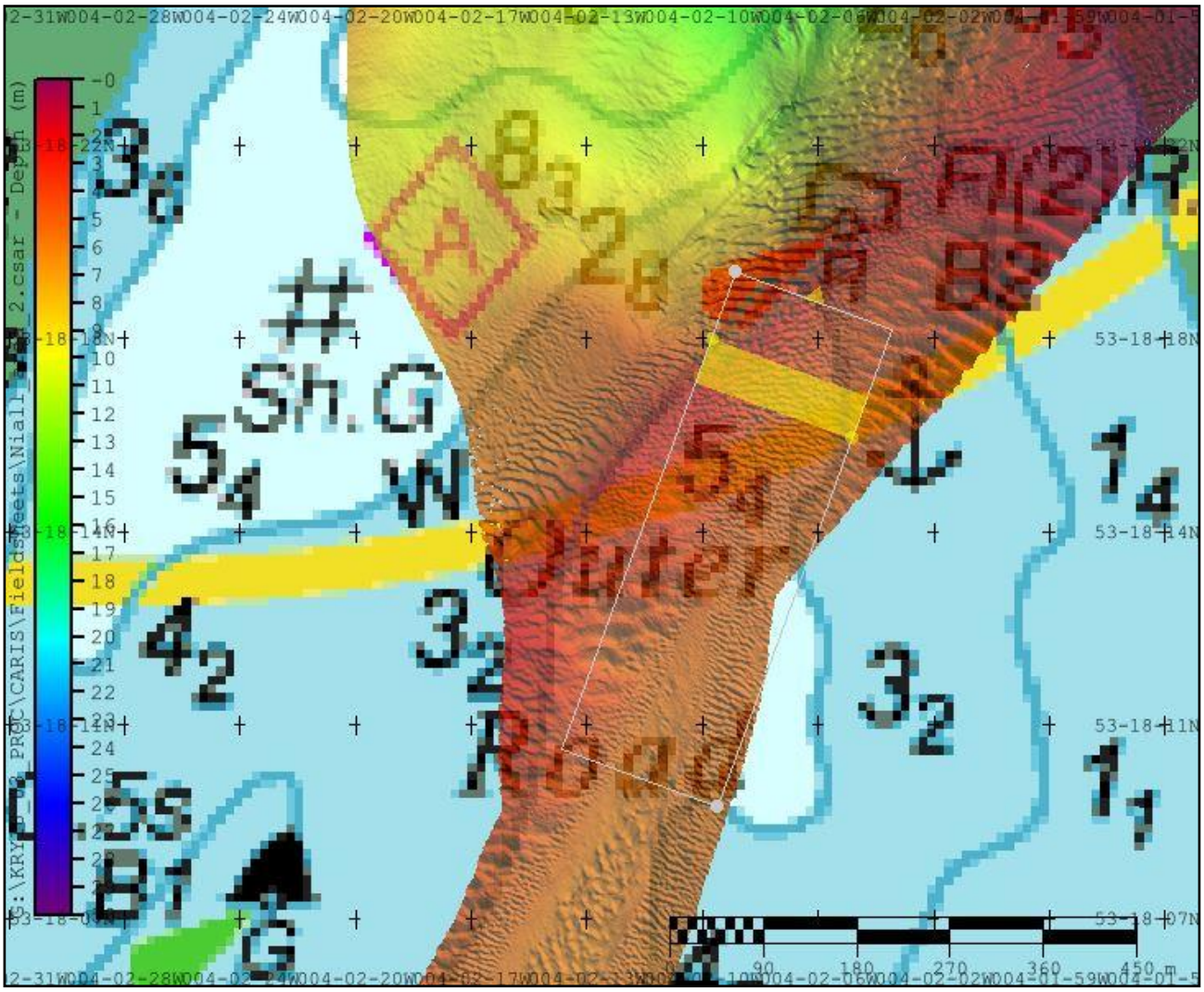

Figure 35 Image showing the sand bank in the area bounded by the 5 m contour

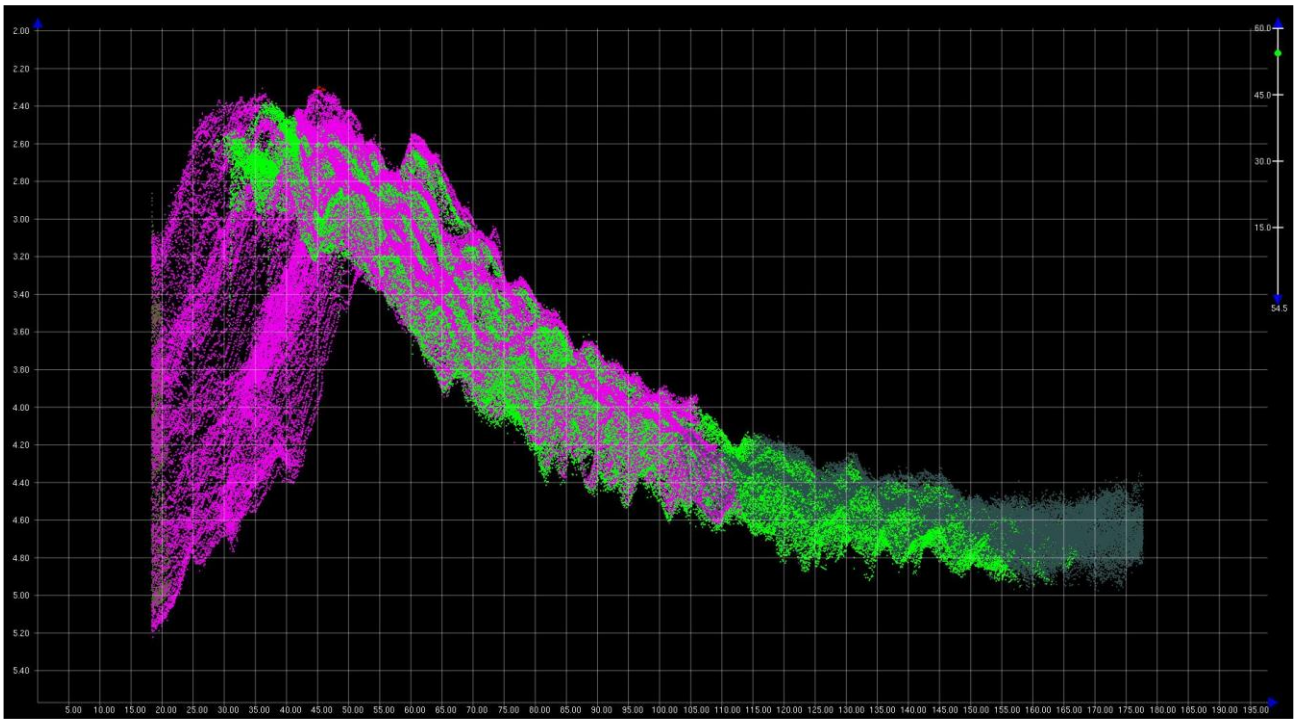

Figure 36 Subset view of the sand bank rising to 2.3 m LAT observed

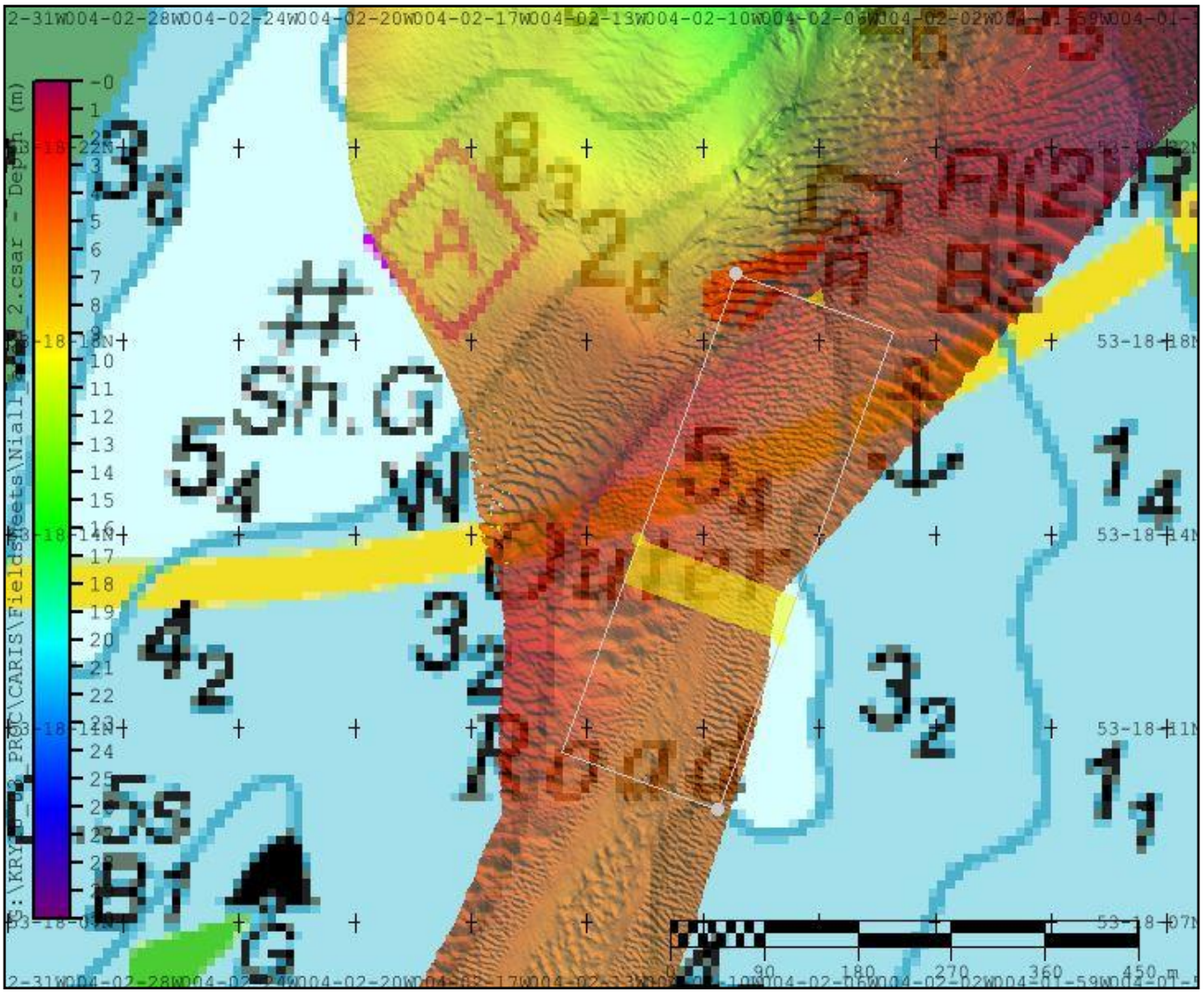

Figure 37 Second location within the area bounded by the 5 m contour

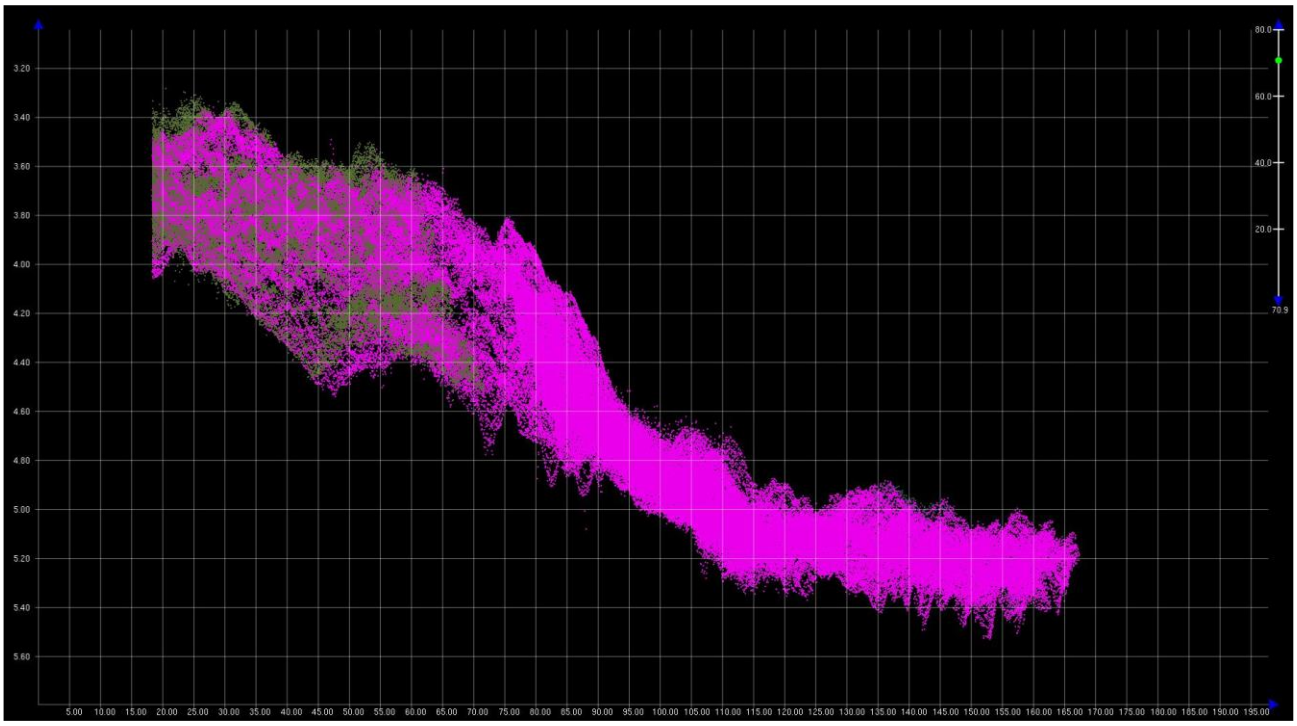

Figure 38 Subset view of the second location (seen in figure 24) showing sand bank rising to 2.4 m LAT observed

Observation 07

Sand wave rising to 2.9 m LAT observed in an area outside 5 m contour and bounded by the 5 m contour. The nearest sounding is 6$_1$. Occurs at 53-13-38.89 N 004-09-08.77 W. This location is just over 1 km north east of the Menai bridge.

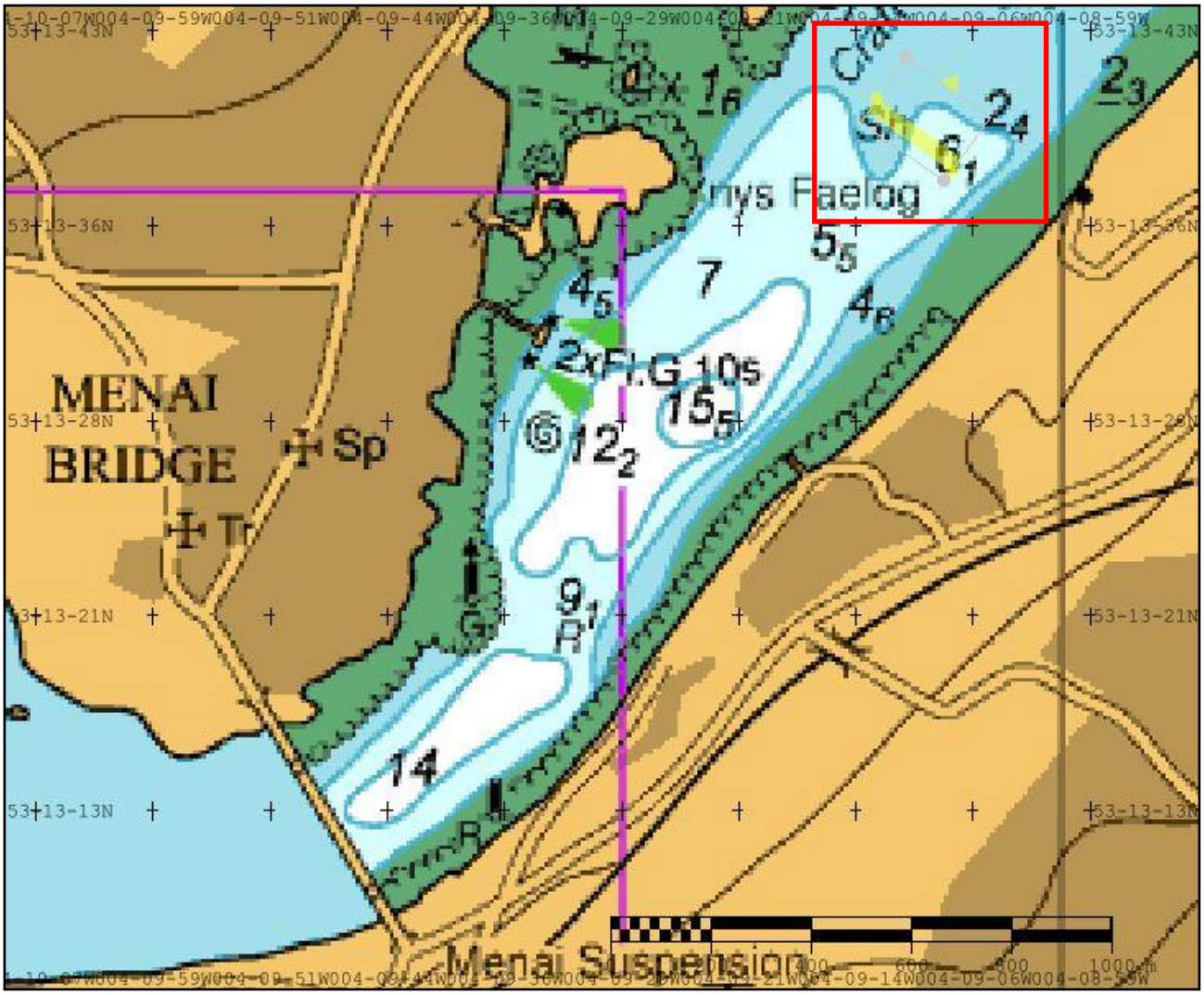

Figure 39 Chart details around the sand wave which is marked by the yellow subset rectangle and a red square

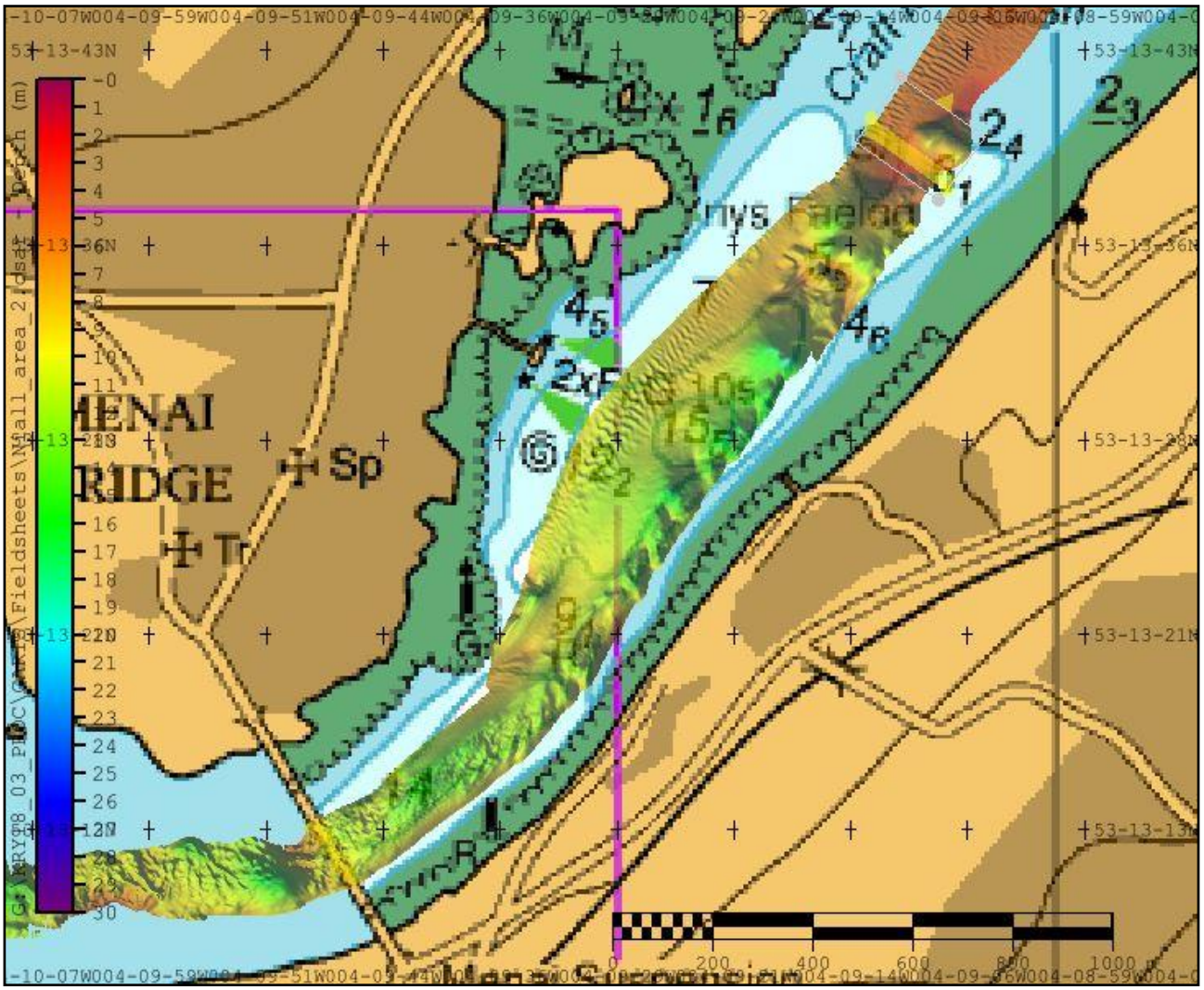

Figure 40 Image showing sandbank with the subset yellow rectangle over it

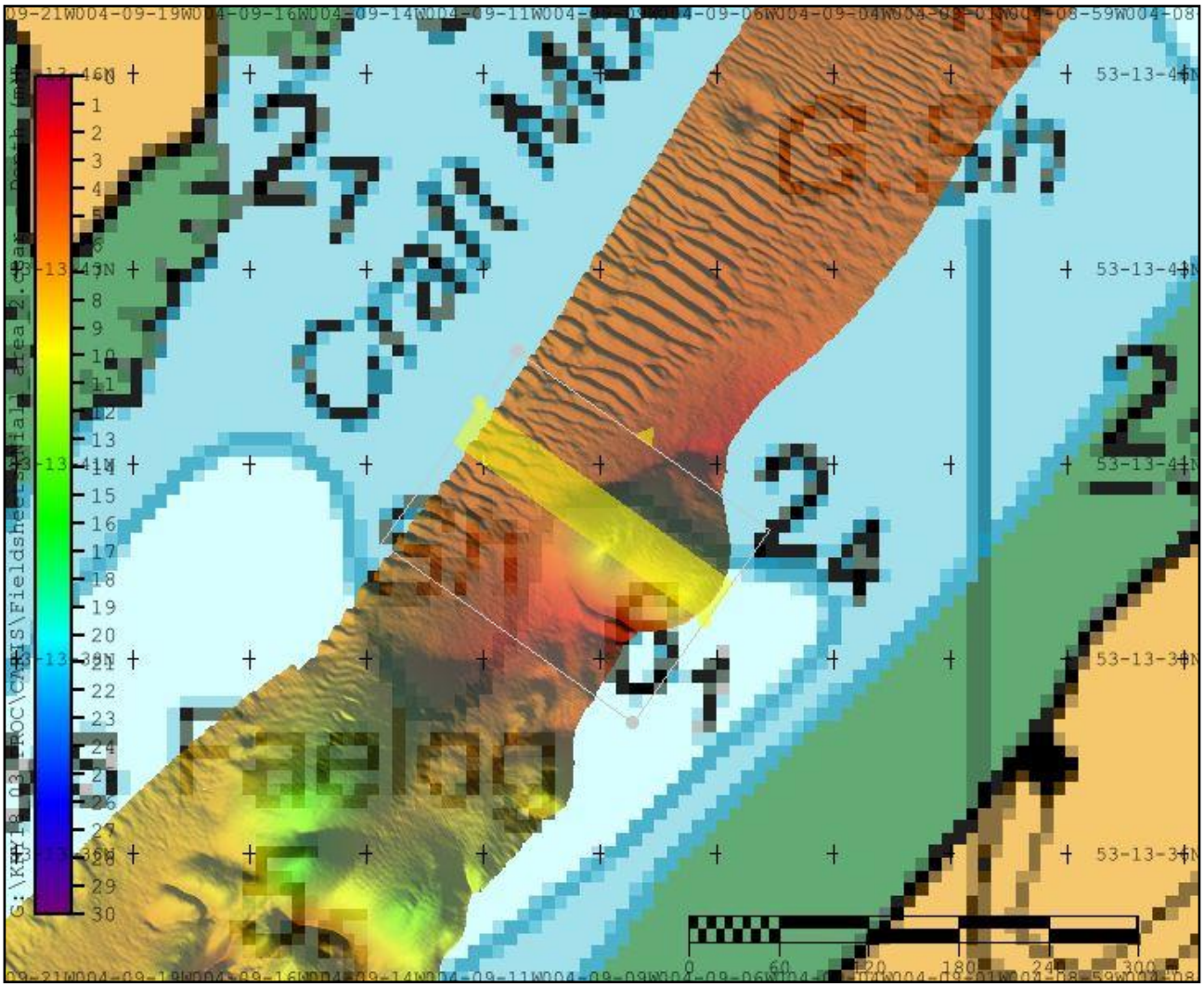

Figure 41 Zoomed image of the sand wave with the yellow subset box moved so the sand wave is visible

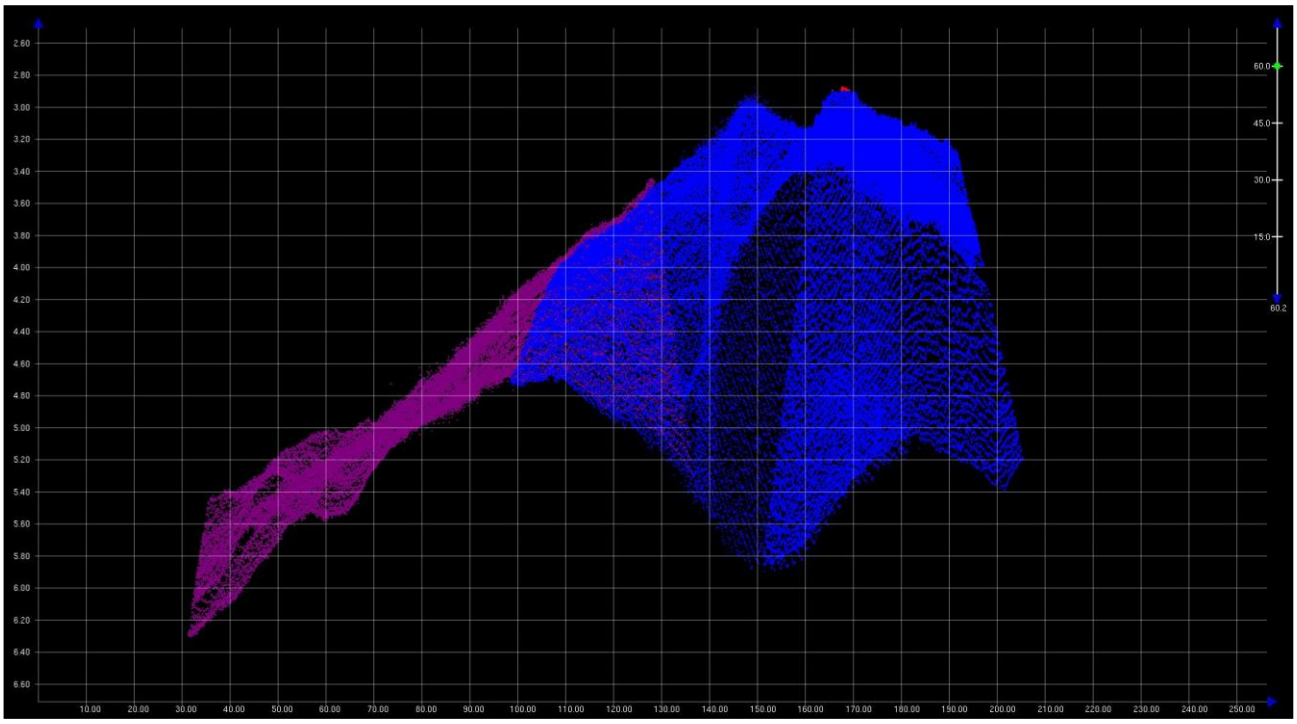

Figure 42 Subset view of the sand wave rising to 2.9 m LAT observed

Observation 08

Shoal rising to 0.5 m LAT observed in an area between the 1 m contour and the 5 m contour. The nearest sounding is 2₈. Occurs at 53-12-59.00 N 004-10-58.61 W. This location is 30 m south west of Cribbin rock.

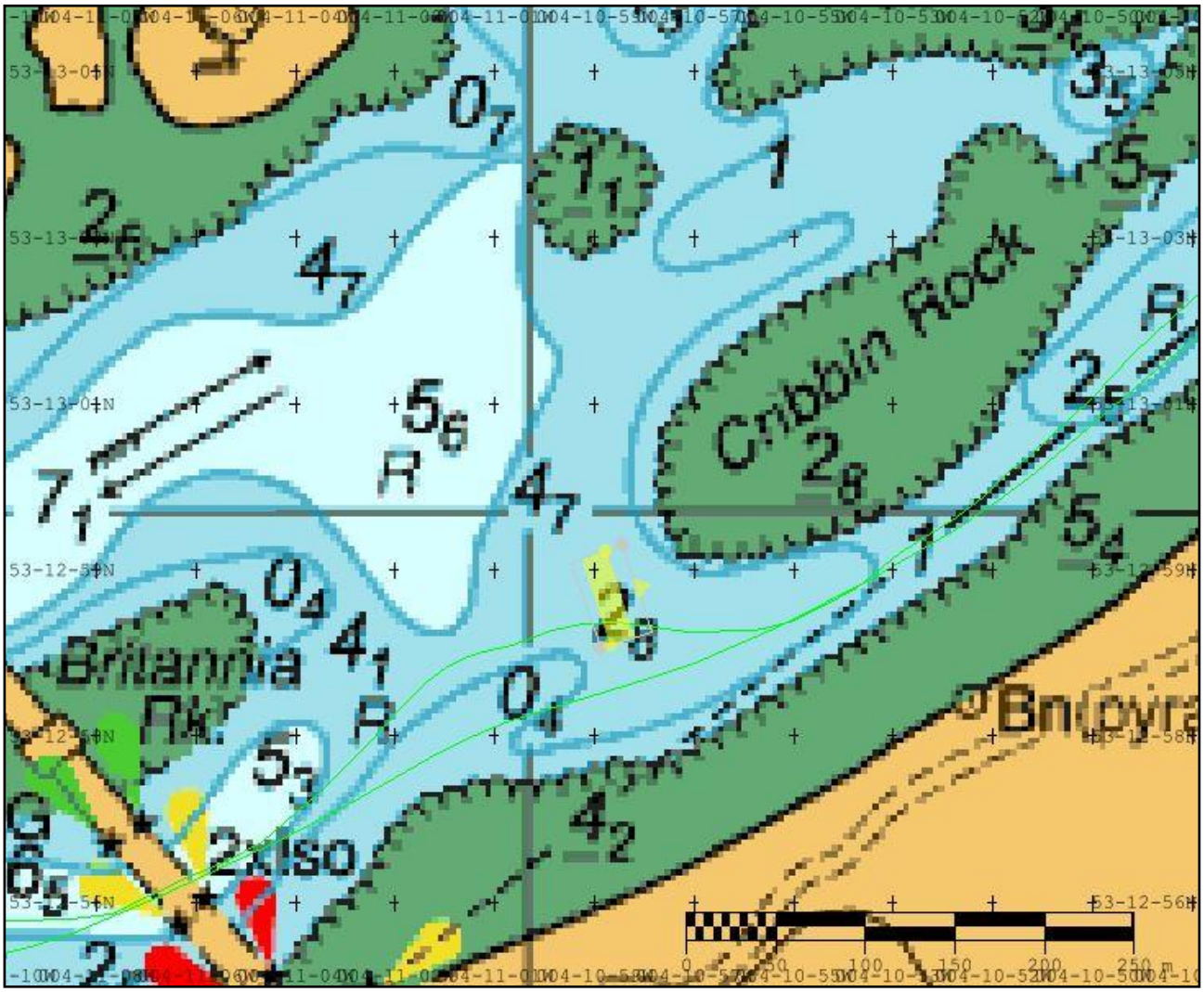

Figure 43 Chart details around the shoal off Cribbin rock

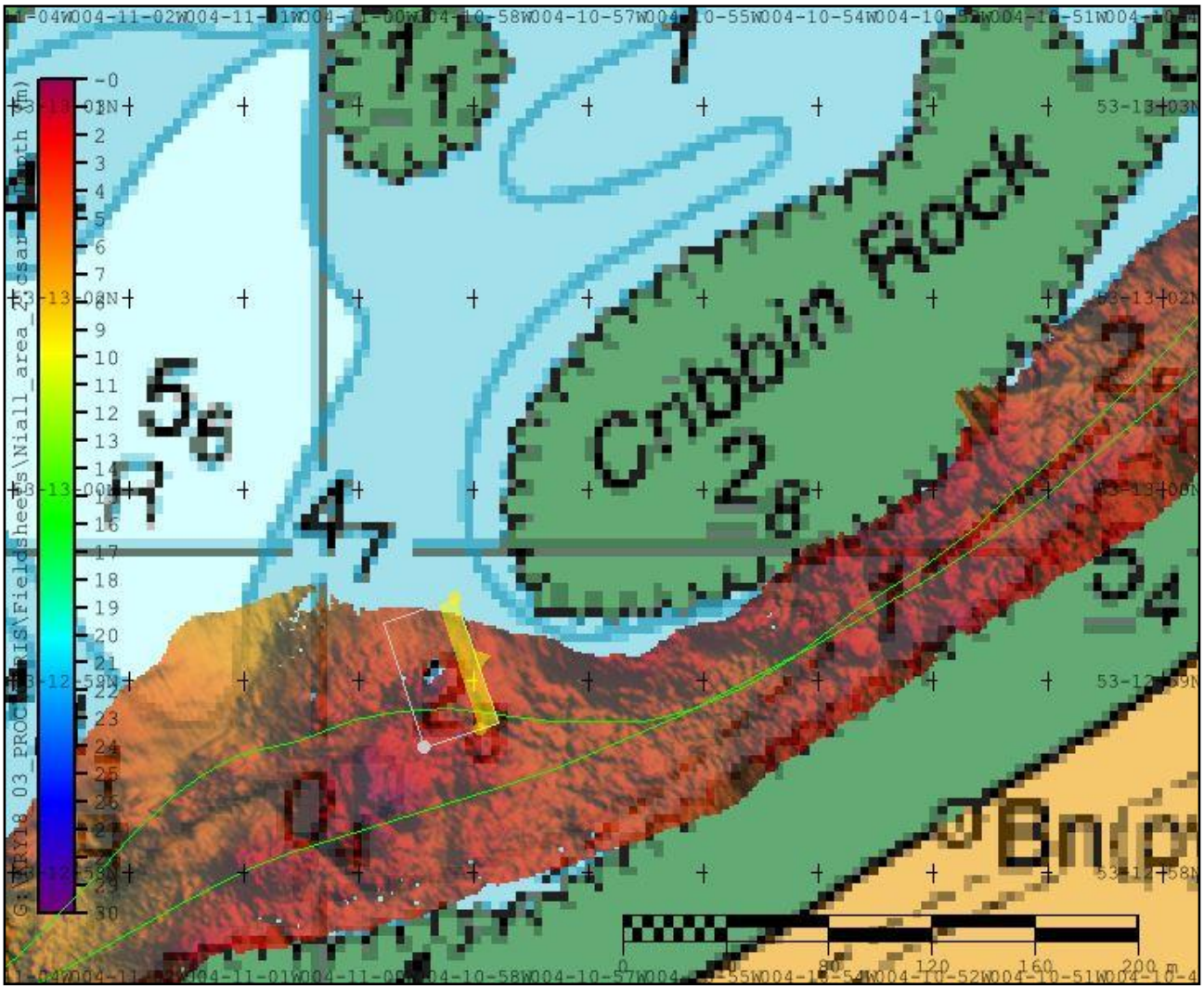

Figure 44 Image showing shoal with subset box over it but with the yellow rectangle moved so the shoal can be seen

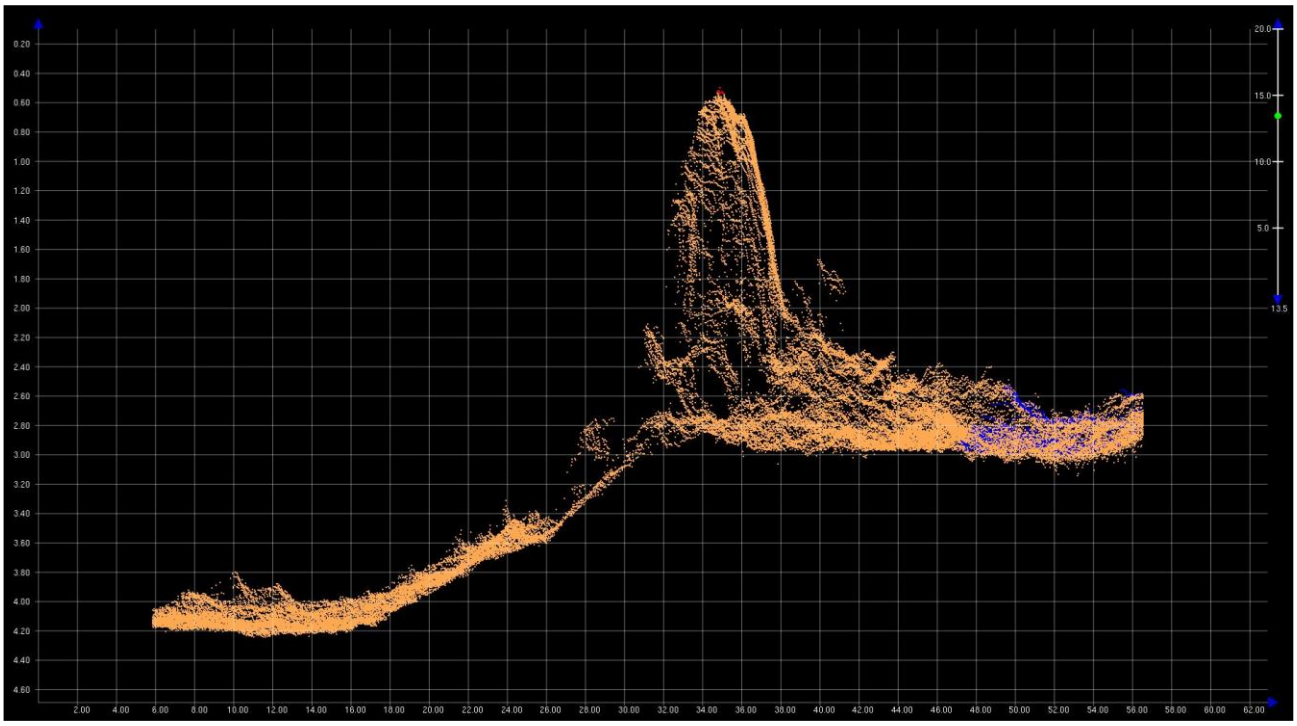

Figure 45 Subset view showing the shoal rising to 0.5 m LAT observed

Observation 09

Rocky shoal rising to 3.5 m LAT observed between the 5m and 10 m contour. Occurs at 53-12-54.89 N 004-11-30.47 W. This location is approx. 380 m West of Britannia Bridge.

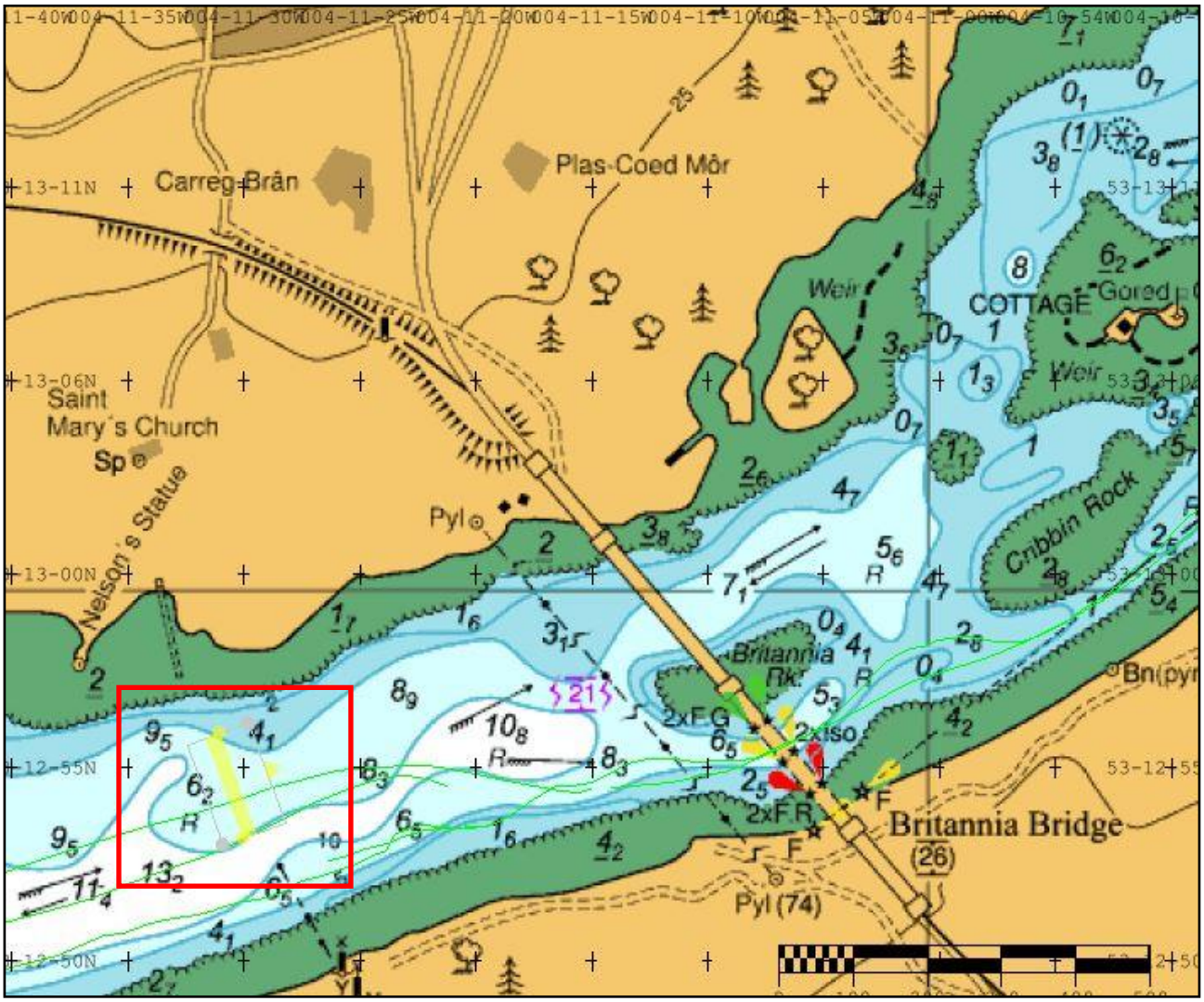

Figure 46 Chart details in location of shoal with subset box showing location of the shoal (also indicated with red square)

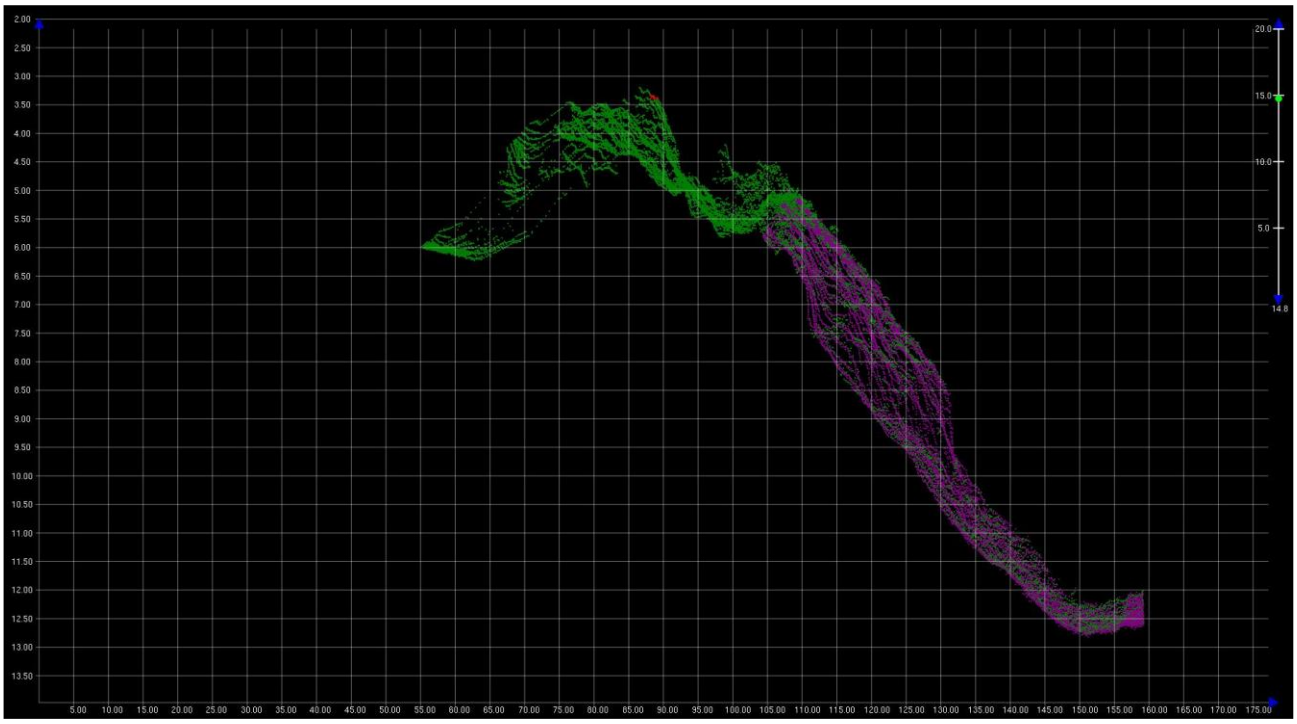

Figure 47 Subset view showing the shoal rising to 3.5 m LAT observed

HYDROGRAPHIC NOTE

H.102
(V8.0 Oct 2014)

Date	21/09/2018		Ref. Number	H102-KRY18_03-003		
Name of ship or sender	Geological Survey of Ireland R.V. Keary					
IMO number if applicable	-					
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland					
E-mail/Tel/Fax of sender	inshore.infomar@gmail.com					
General Locality	Southern entrance to Menai strait and some of the menai strait itself which is located on the south eastern coast of Anglesey					
Subject	Multiple observations on the southern section of the menai strait and the southern entrance to the Menai strait.					
Position *(see Instruction 2)*	Latitude	See following pages		Longitude	See following pages	
	GPS	POSpac -PPK	Datum	WGS 84	Accuracy	0.1m
Admiralty Charts affected	1970-0, 1464-1			Edition	Unknown	
Latest Weekly Edition of Notice to Mariners held	Unknown					
Replacement copy of Chart No (*see Instruction 3)*	**IS NOT** required					
ENCs affected						
Latest update disk applied	Week:					
Make, model and or age of ECDIS if applicable	Qinsy/Caris					
Publications affected (NP/DP number, Edition No.)	Unknown					
Date of latest supplement/update, page & Light List No. etc	Unknown					

Details of anomaly / observation:
Area surveyed as part of Irish-Wales CHERISH project. Observed depths differ from charted depths in a number of locations throughout the area surveyed. This data has not yet been finalised.

Data acquired by R.V. Keary:
- equipped with Kongsberg EM2040D and POSmv 320 Wavemaster. All depths are reduced to VORF LAT using GPStide methods. Navigation data is reprocessed using PP-RTX and transformed to ETRS89.

Name of observer/reporter	Niall Finn
H.102A Submitted No	H.102B Submitted No

Tick box if not willing to be named as source of this information	☐

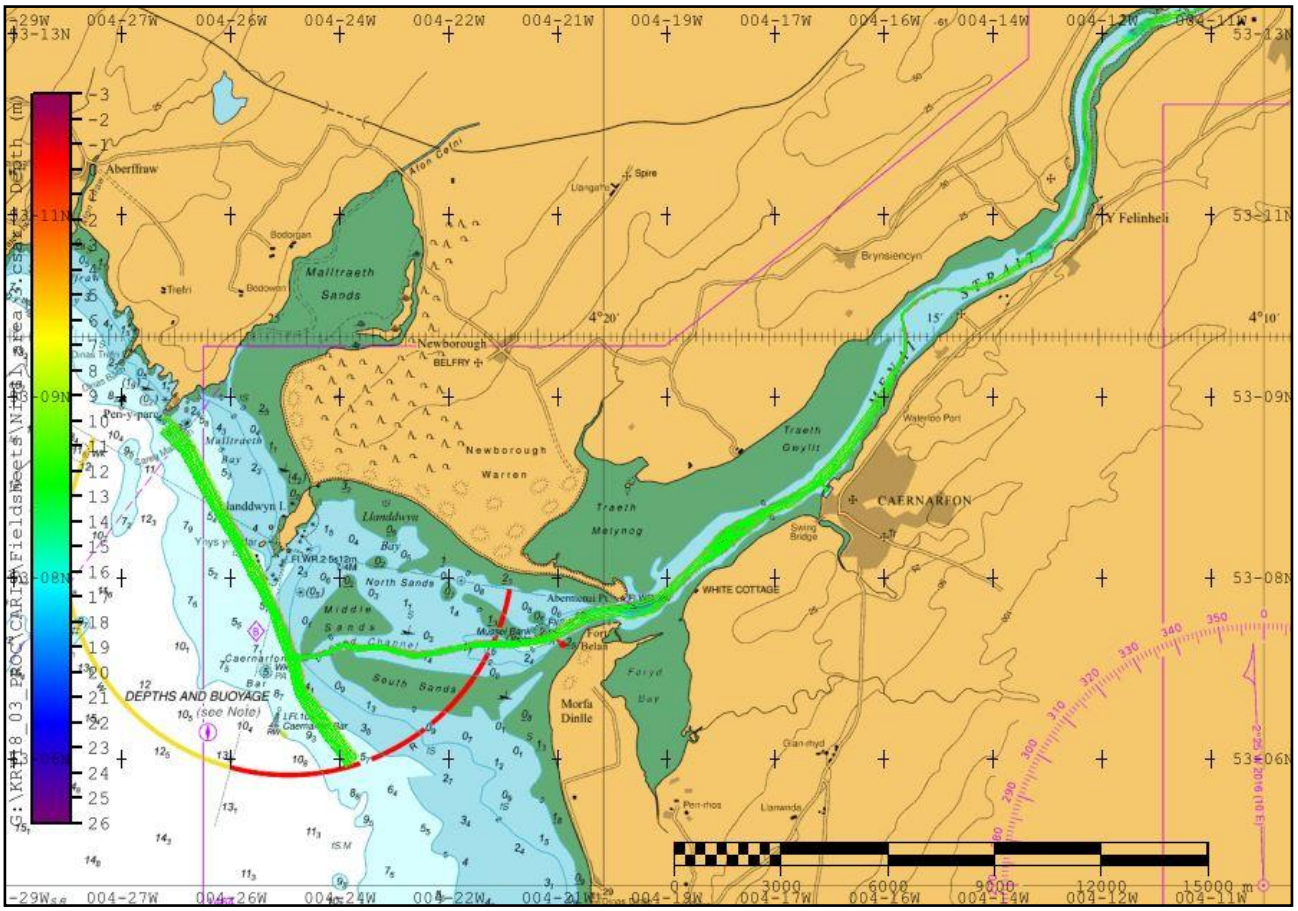

Figure 48 This is the area this H-Note will focus on

Observation 01

Sand bank rising to 1.0 m LAT observed in an area charted at 5 m. Occurs at 53-10-25.38 N 004-14-52.00 W.

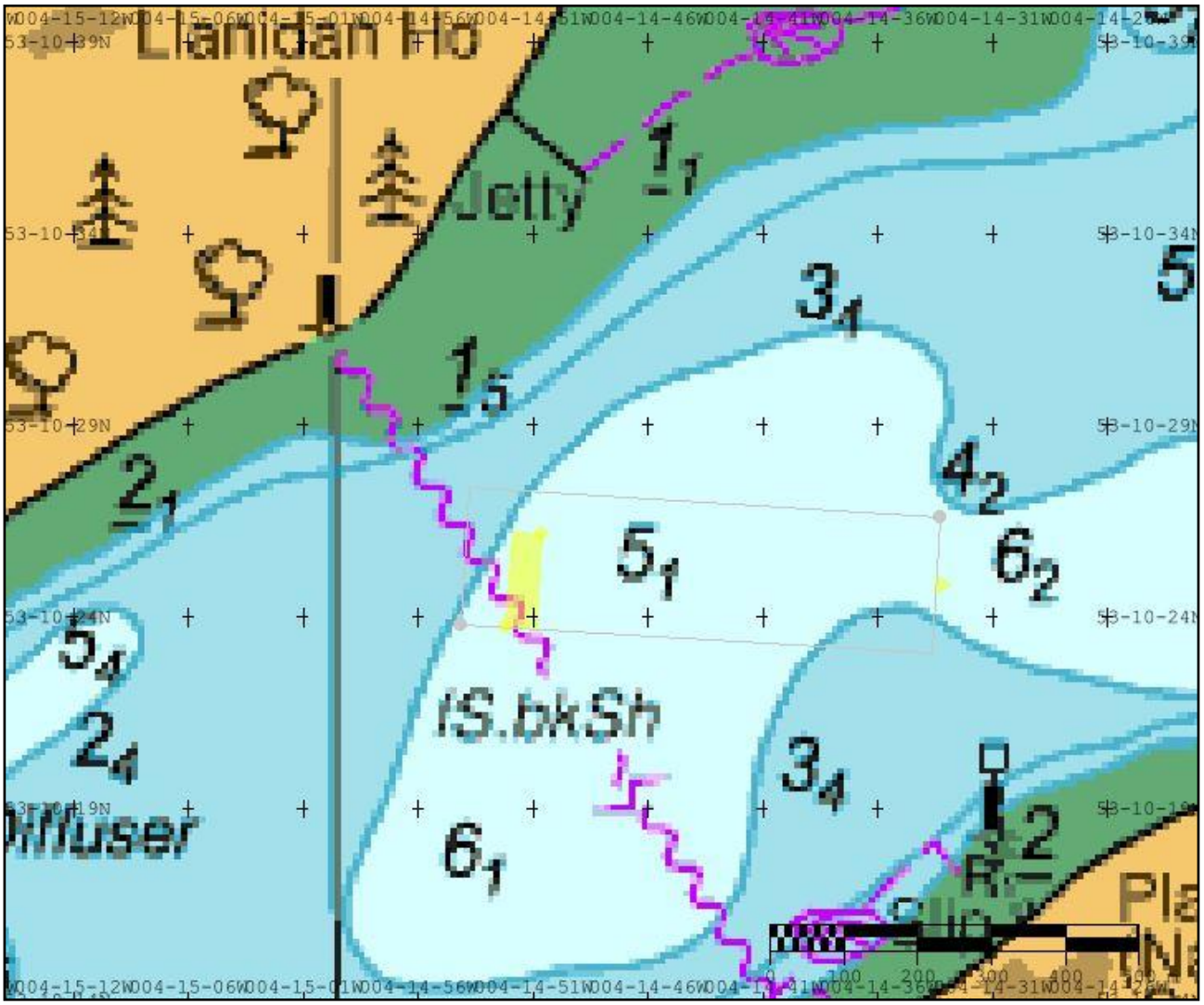

Figure 49 Chart details in the area containing the sand bank which rises to 1 m LAT observed

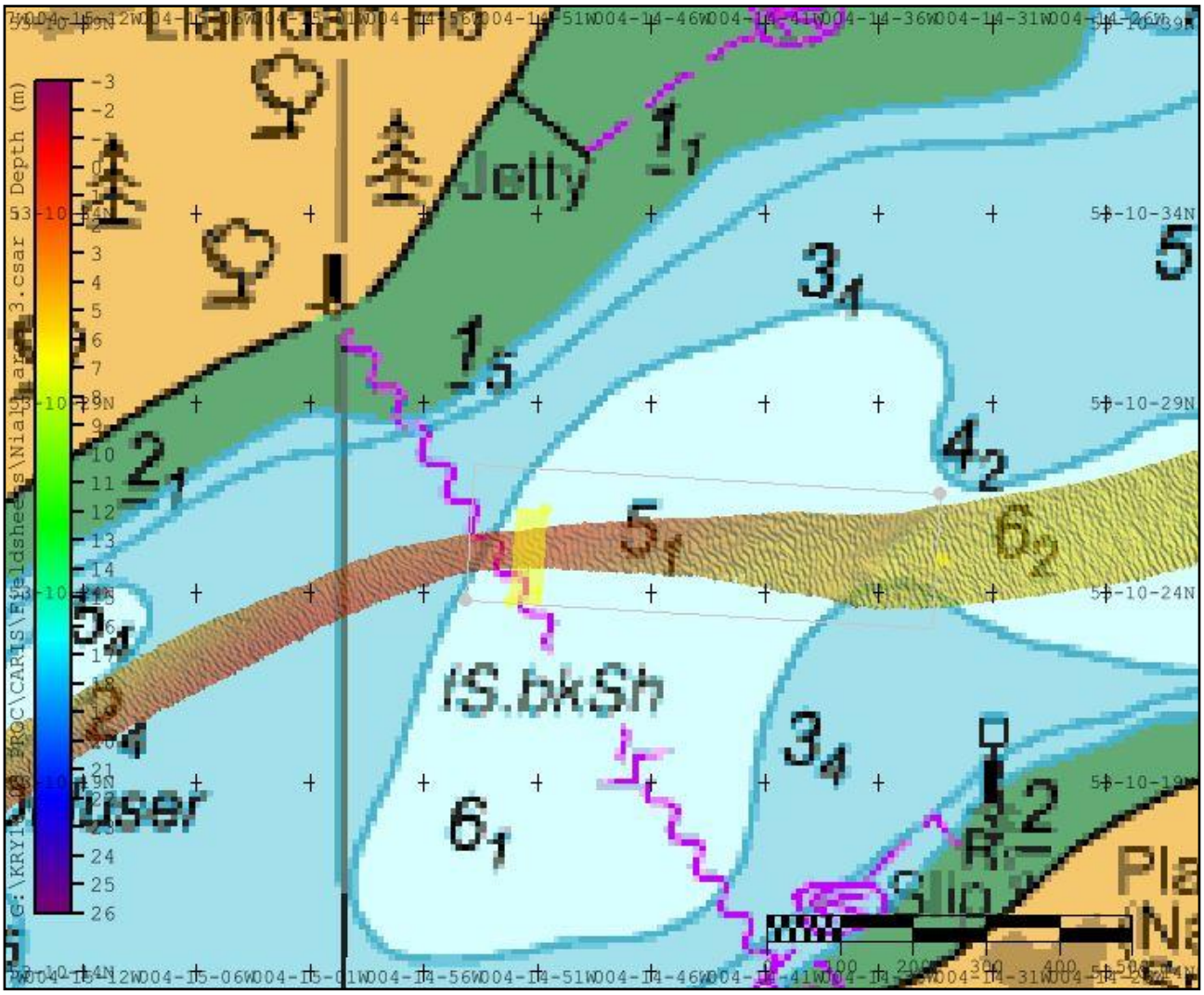

Figure 3 Image showing the subset rectangle over an area where bank rises to 1 m LAT observed

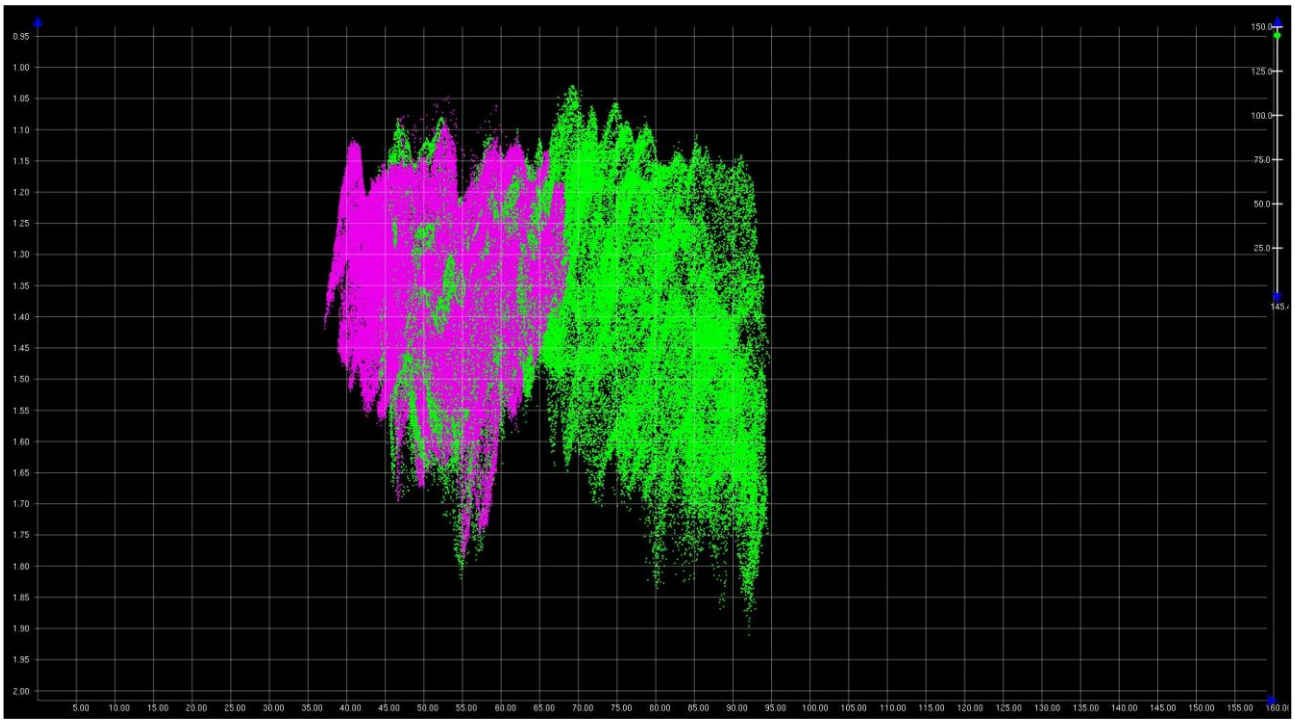

Figure 4 Subset view showing sand bank rising to 1 m LAT observed

Almost all of the area within the subset box is less than 5 m. I will include a number of images with the subset yellow rectangle in a number of areas.

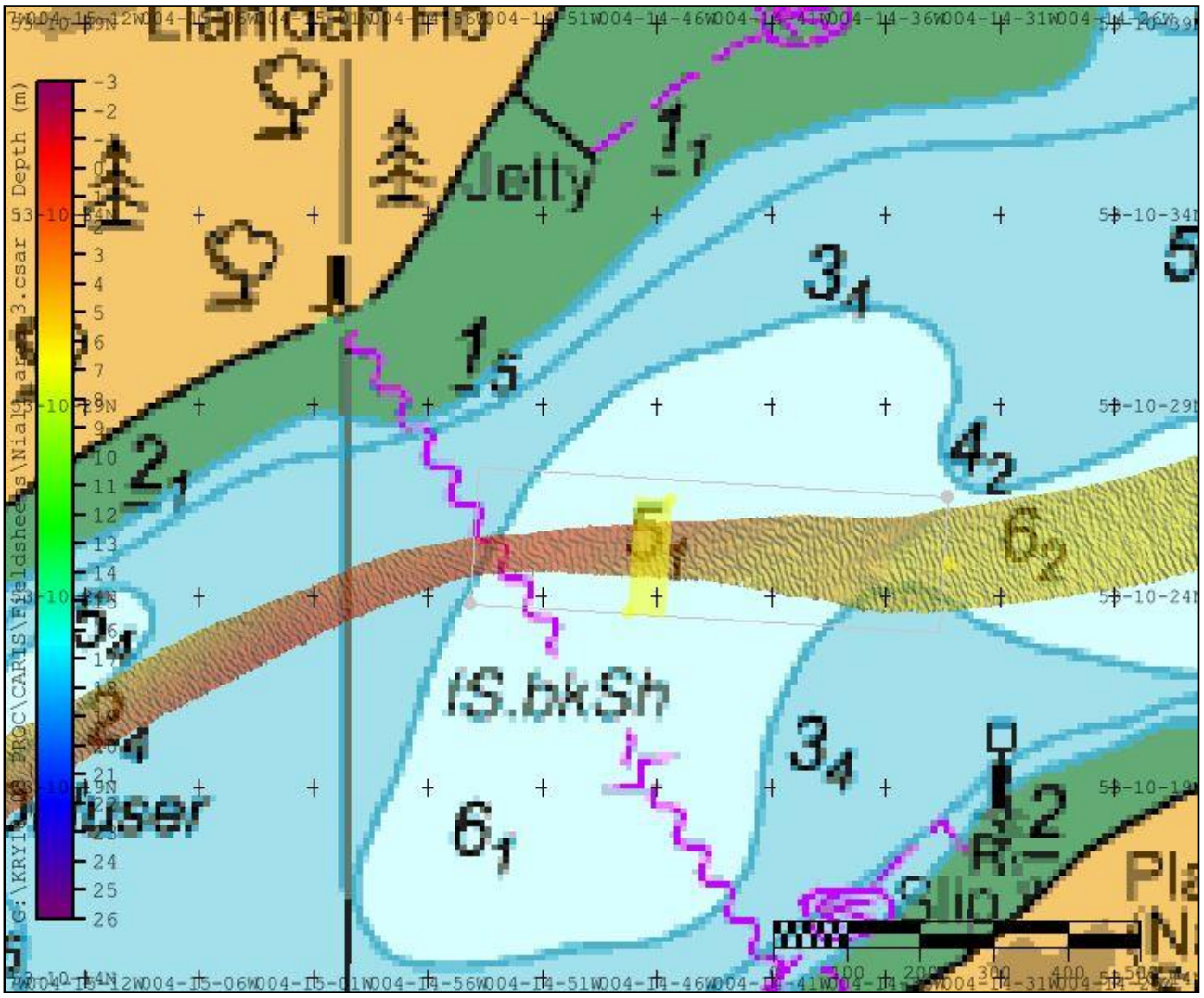

Figure 5 Image of the sandbank with the yellow rectangle located where the 51 sounding is on the chart

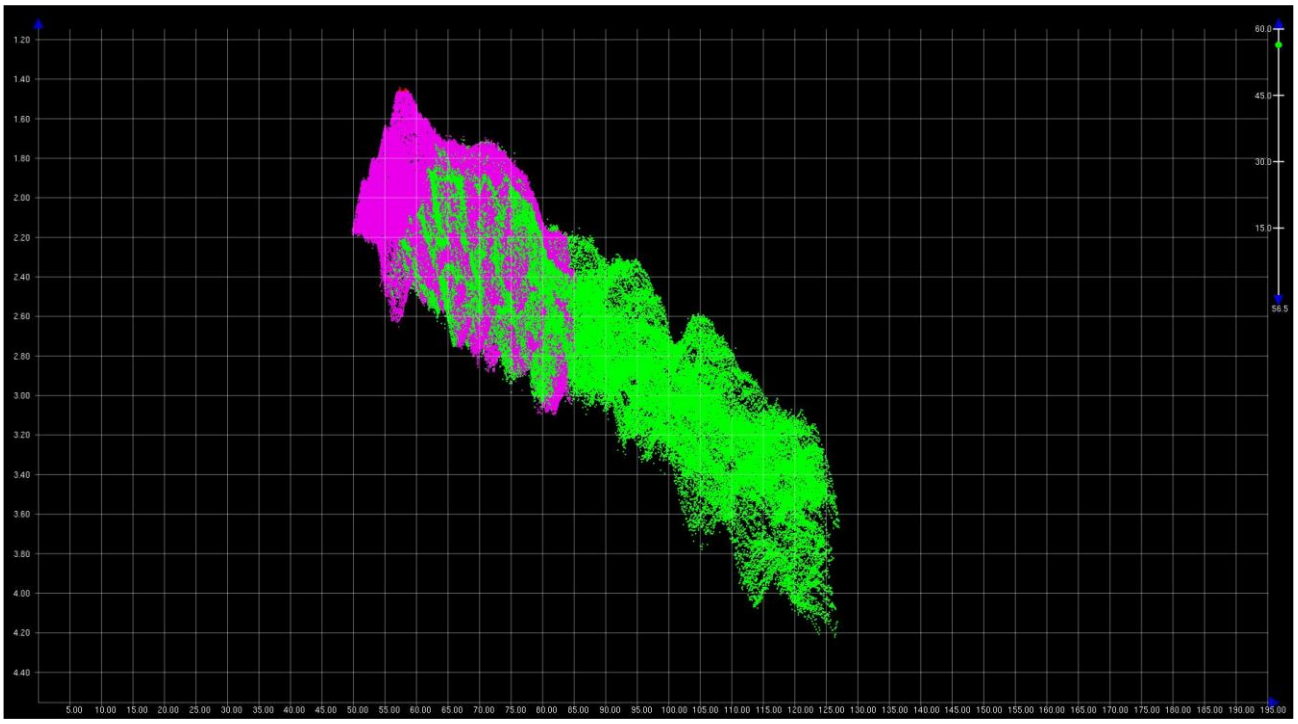

Figure 6 Subset view of the sand bank rising to 1.4 m LAT observed directly over 51 sounding on chart

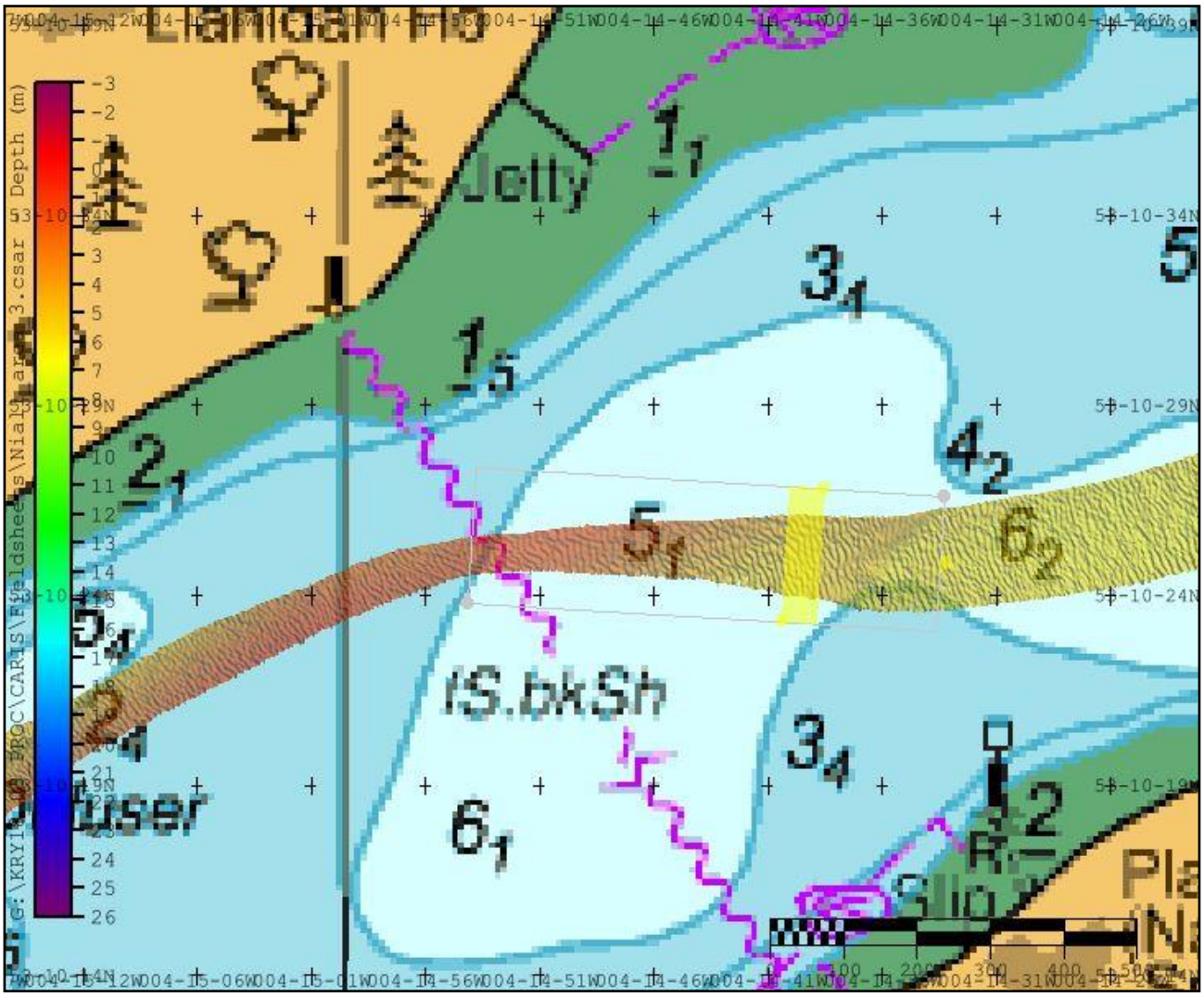

Figure 7 Image with yellow subset rectangle in a different location

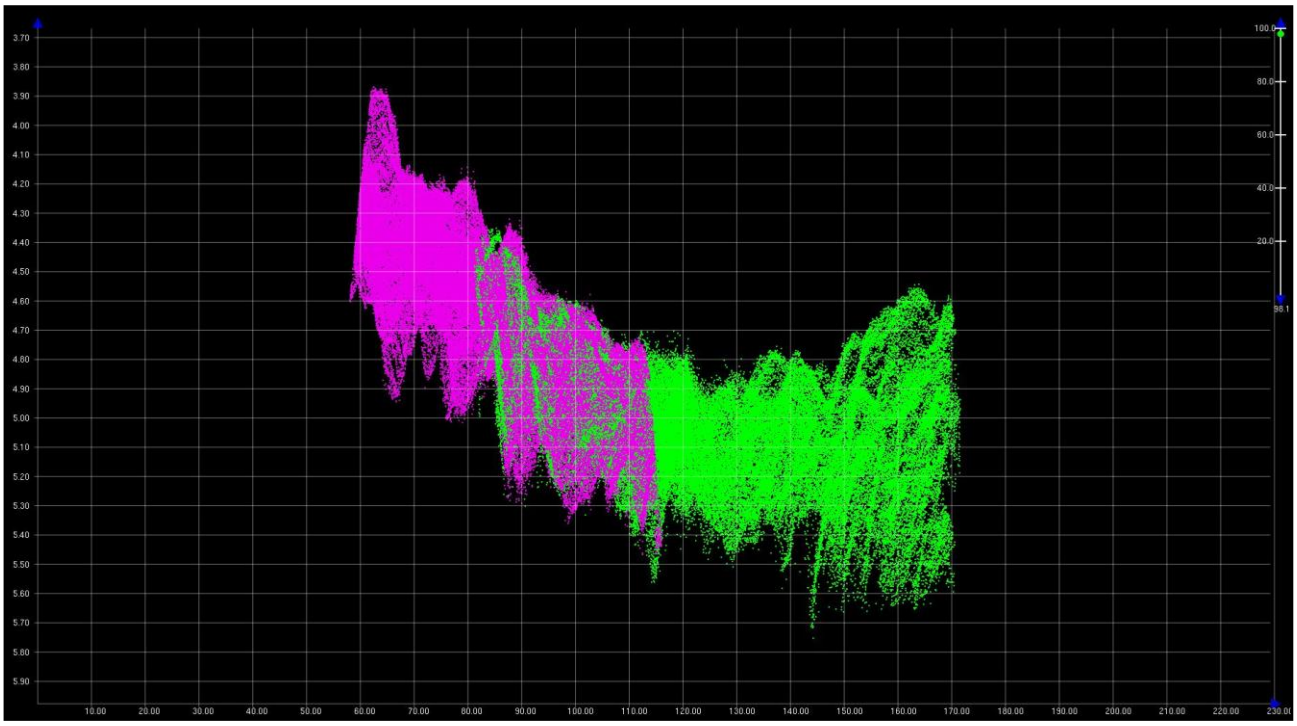

Figure 8 Subset view (of figure 7) showing sand bank rising to 3.9 m LAT

Observation 02

Sandbank rising to 3.7 m LAT observed inside 5 m contour. Occurs at 53-10-16.06 N 004-15-24.32 W. This is located in an area bounded by a 5 m contour beside the coast. The sand bank rises to less than 5 m all along the contour line.

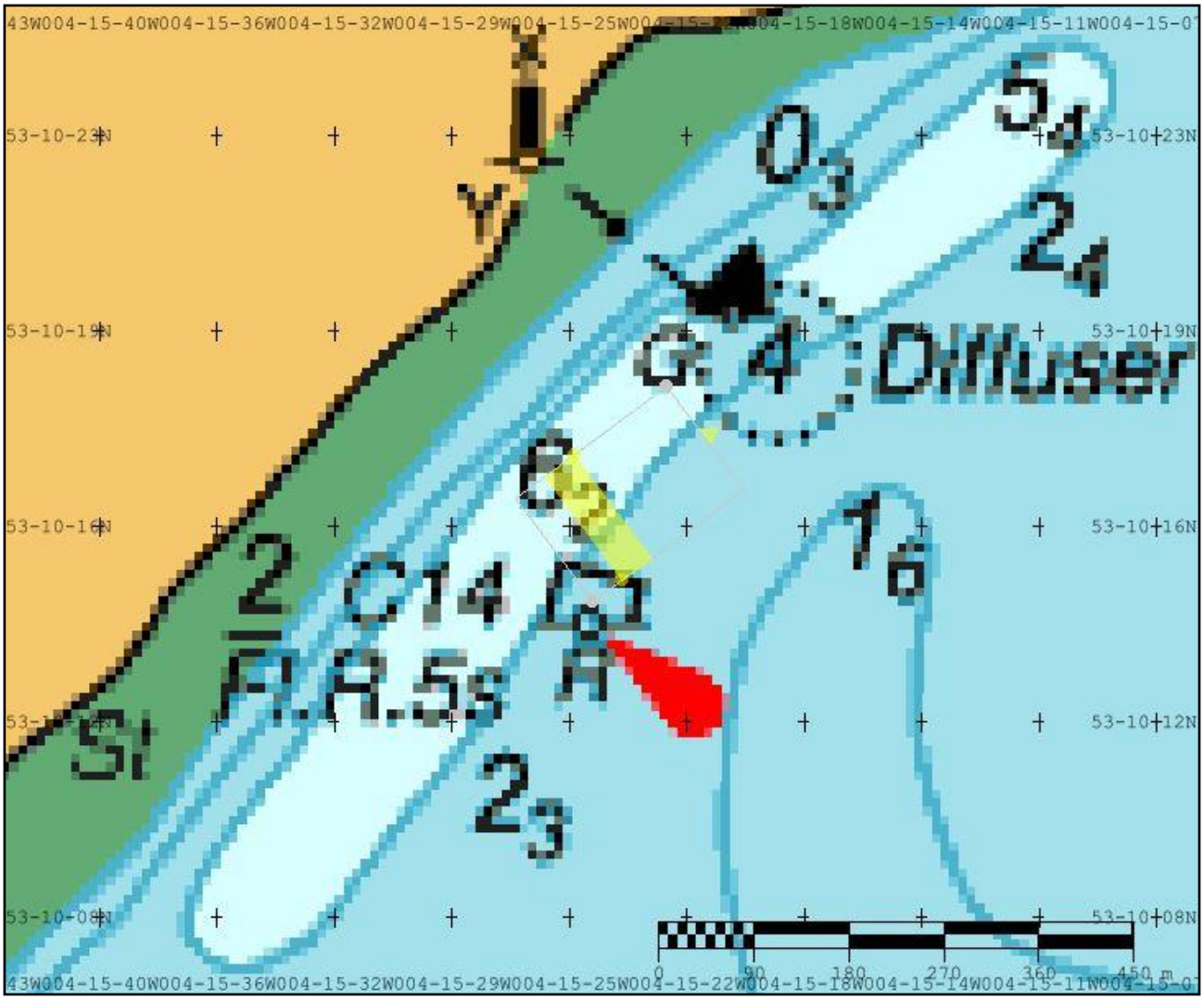

Figure 9 Chart details in area where sand bank rises to 3.7 m LAT observed

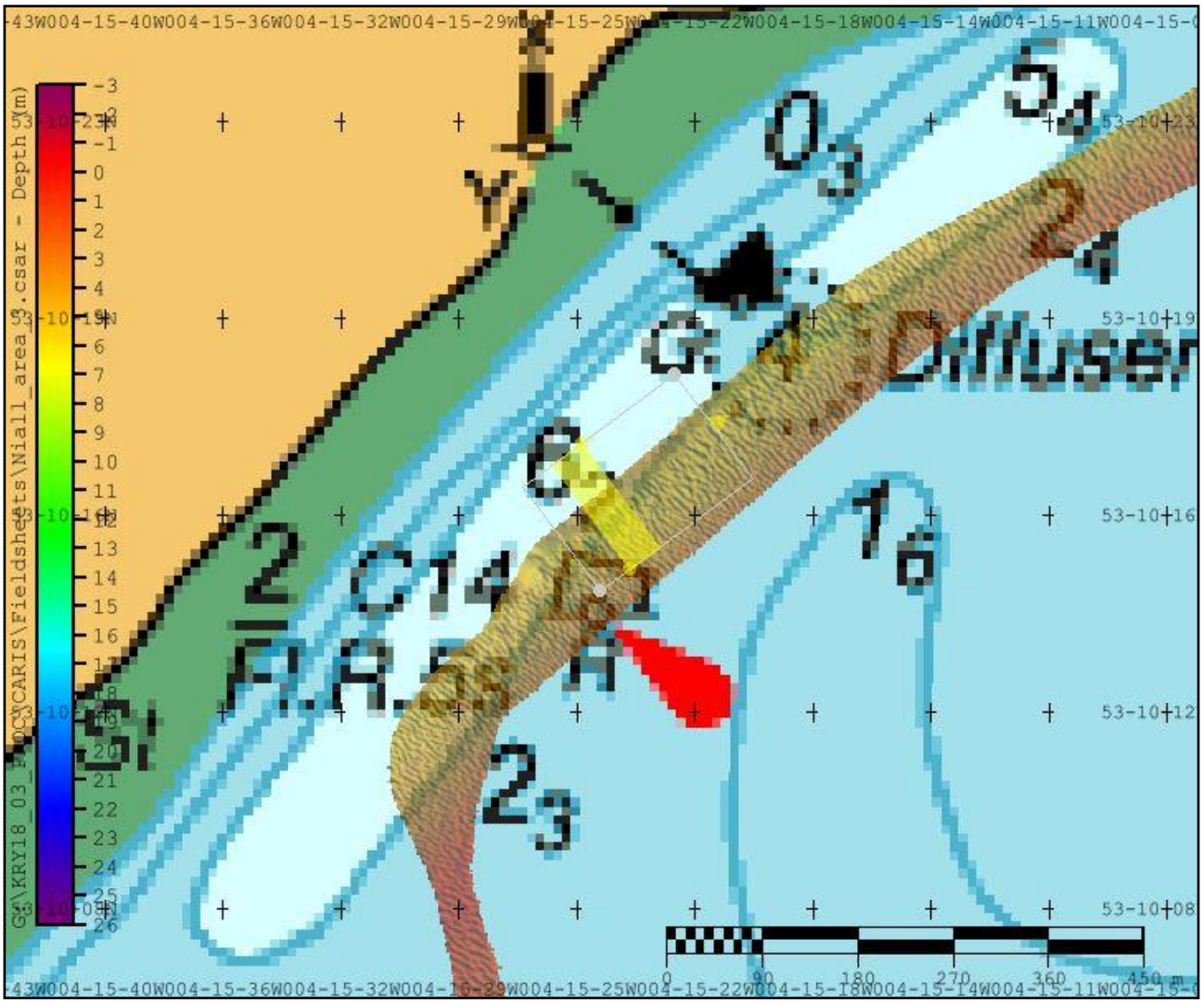

Figure 10 Image showing sand bank which rises to 3.7 m LAT observed inside 5 m contour

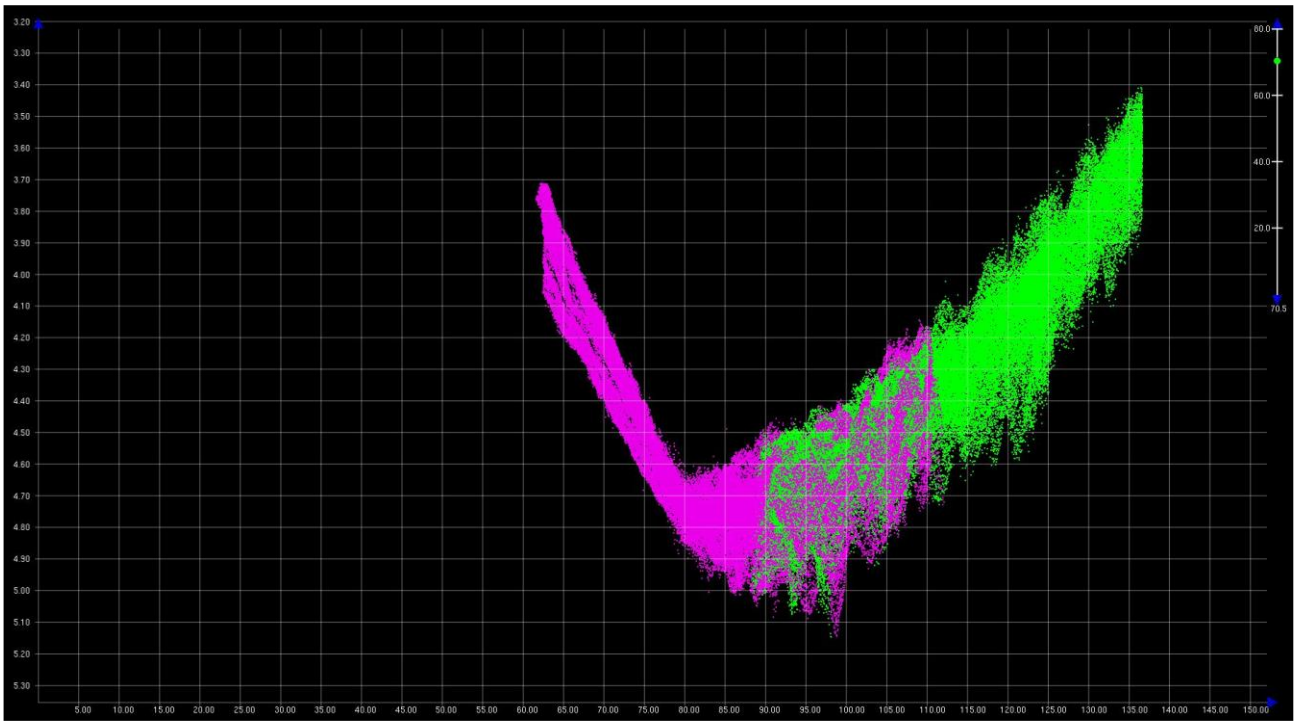

Figure 11 Subset view showing sand bank rising to 3.7 m LAT observed

The sand bank rises to less than 5 m all along this contour.

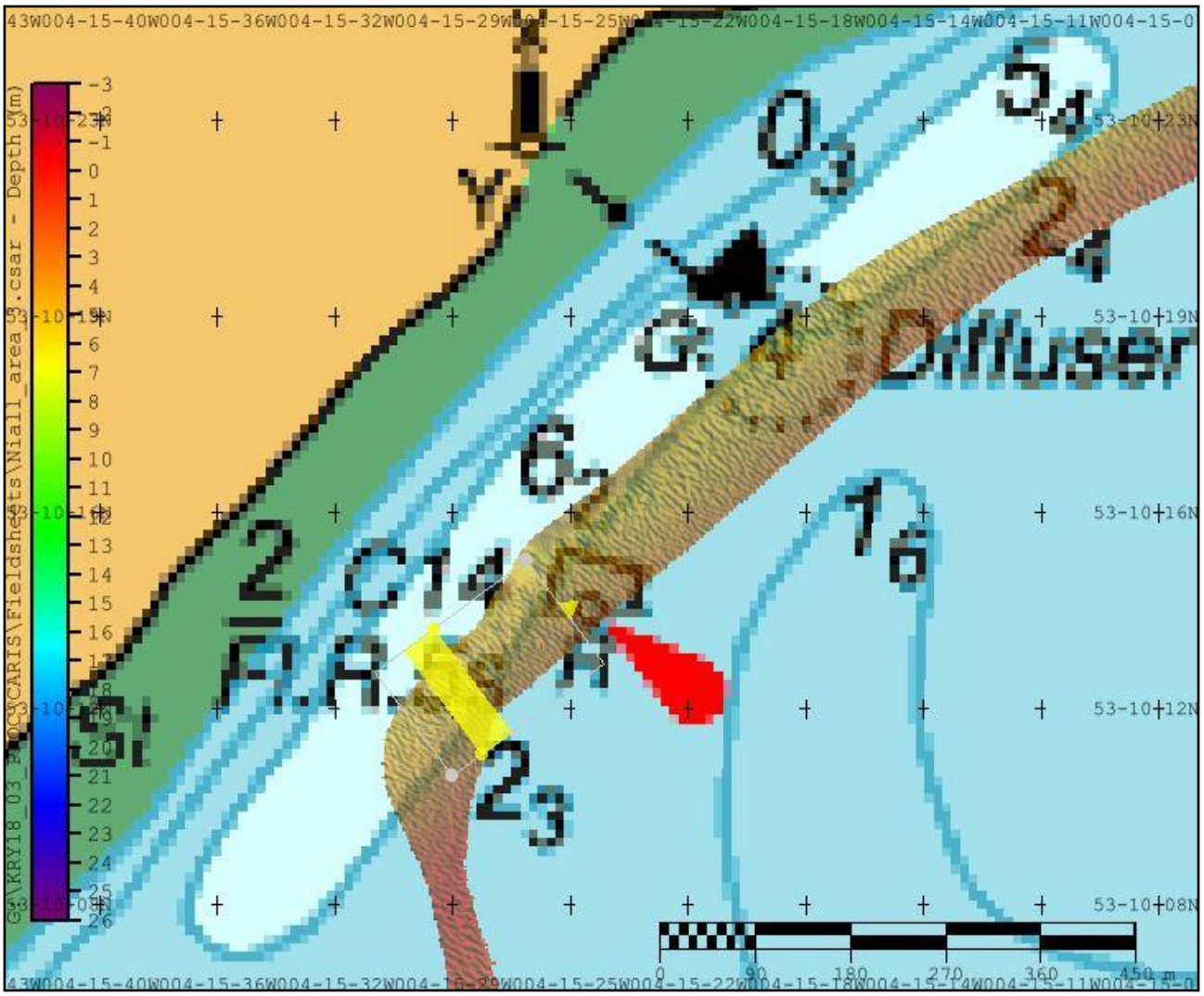

Figure 12 Image showing the subset rectangle in a different location along the bank

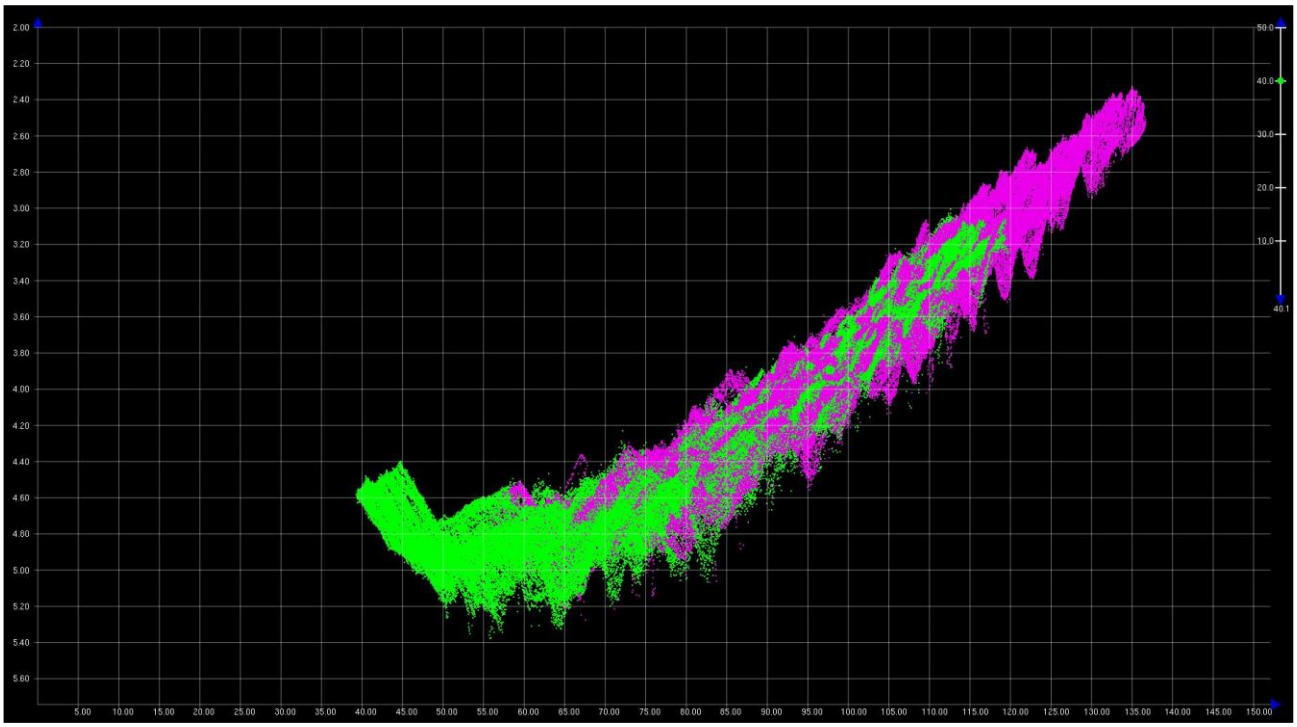

Figure 13 Subset view of the sand bank from figure 12

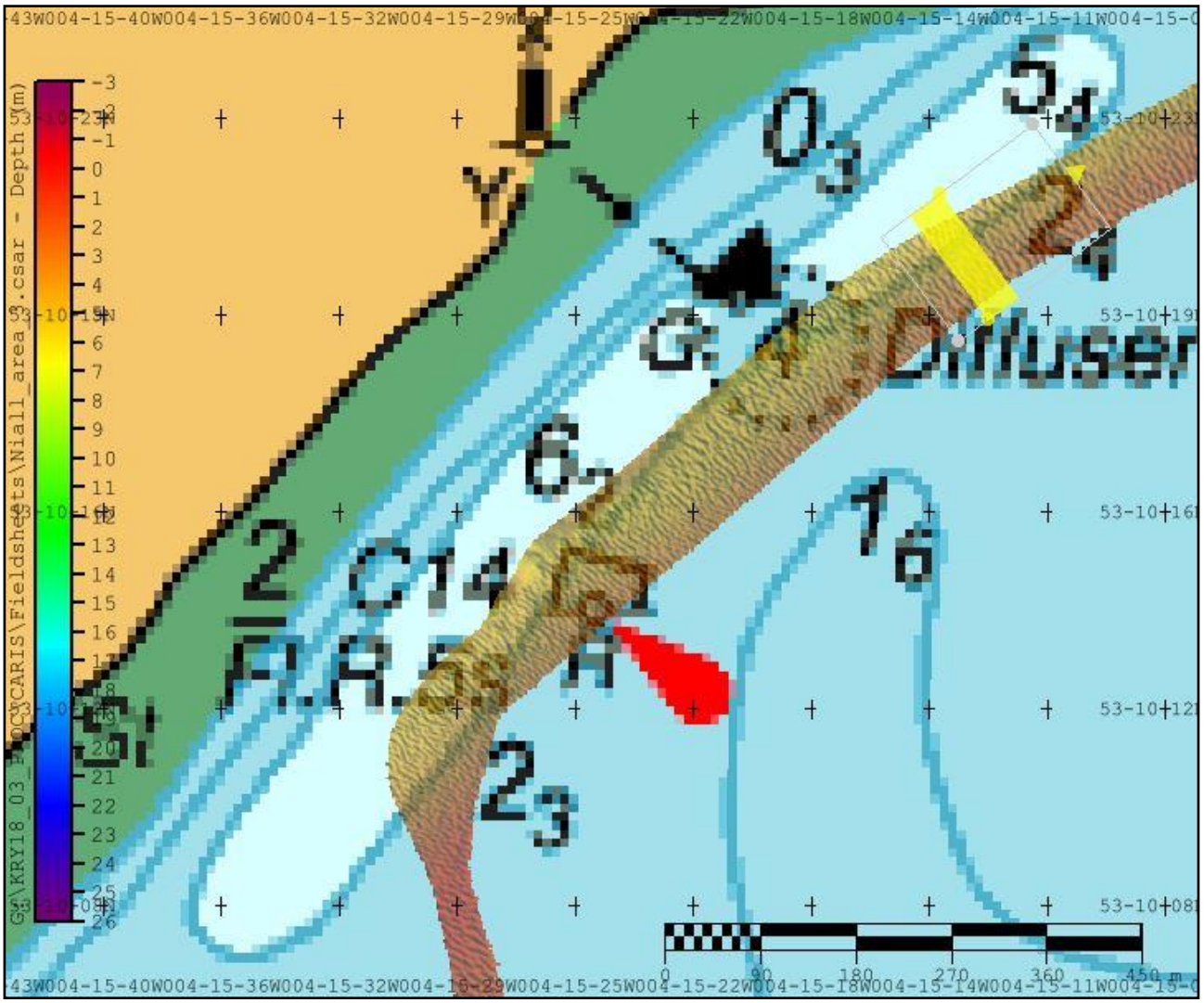

Figure 14 Image showing the subset rectangle in a third location along the bank

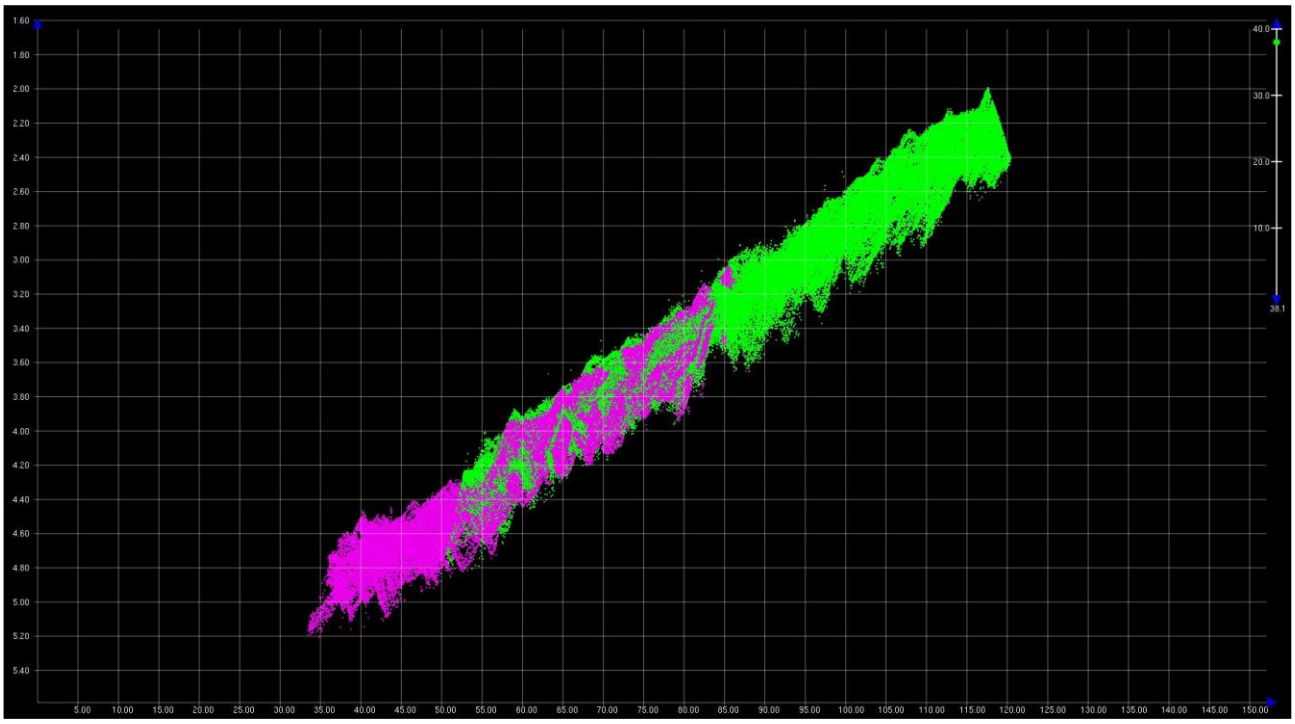

Figure 15 Subset view of the sand bank from figure 14

Observation 03

Sand bank rising to 0.07 m LAT observed in an area charted at 2 m. Occurs at 53-10-08.17 N 004-15-29.16 W.

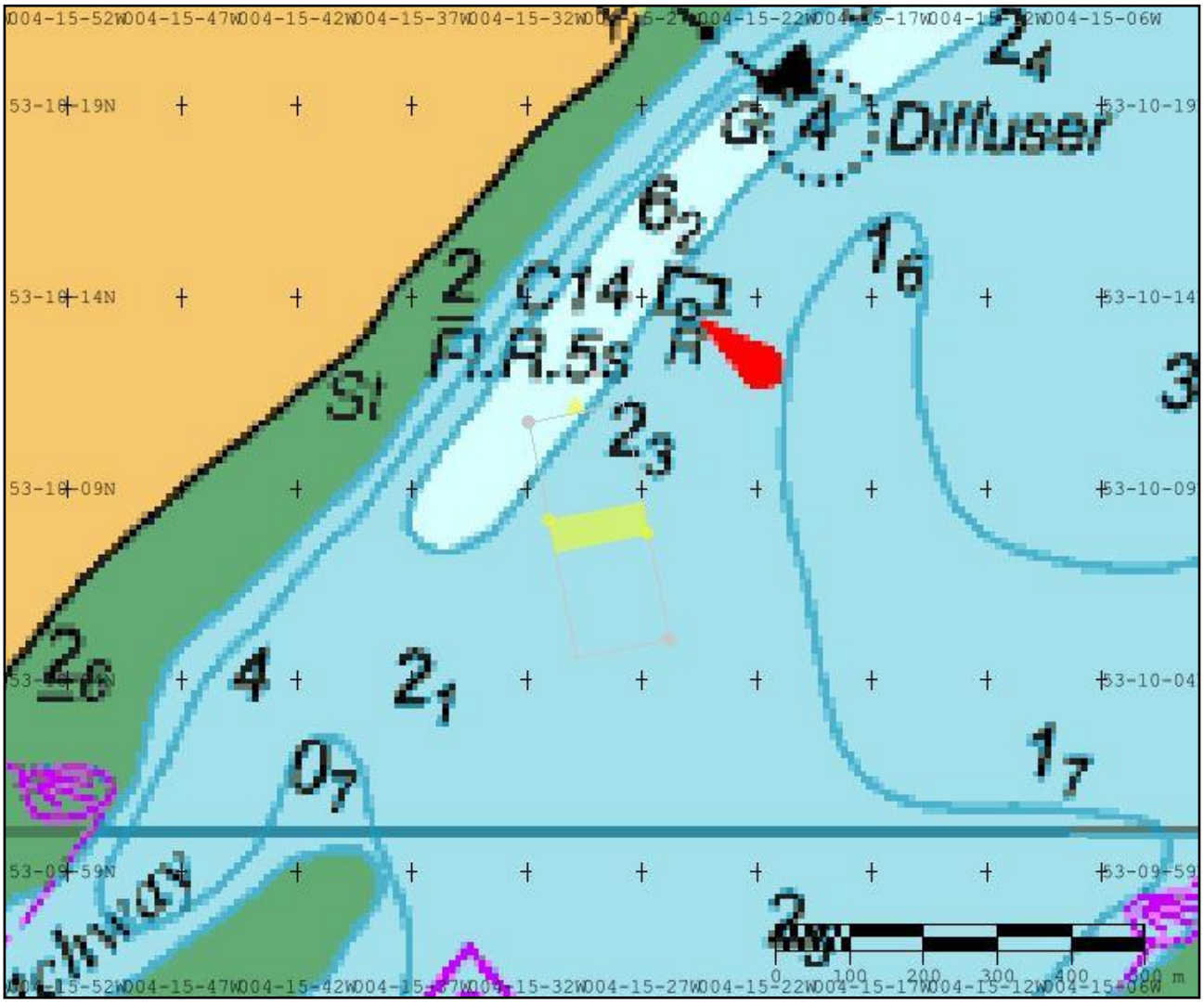

Figure 16 Chart details in the area of the sand bank which rises to 0.07 m LAT observed with the yellow subset rectangle over the sand bank

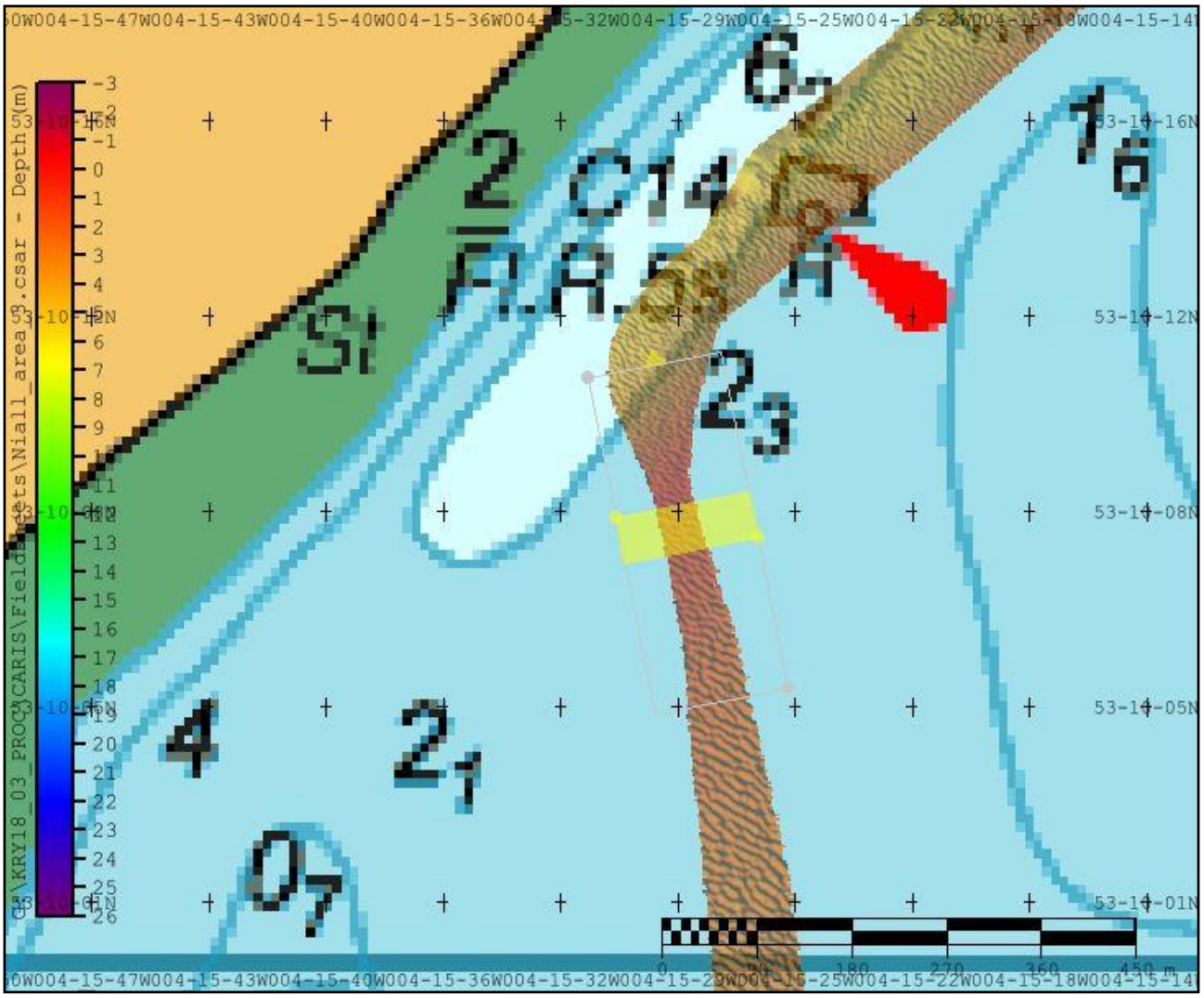

Figure 17 Image showing the sand bank which rises to 0.07 m LAT observed

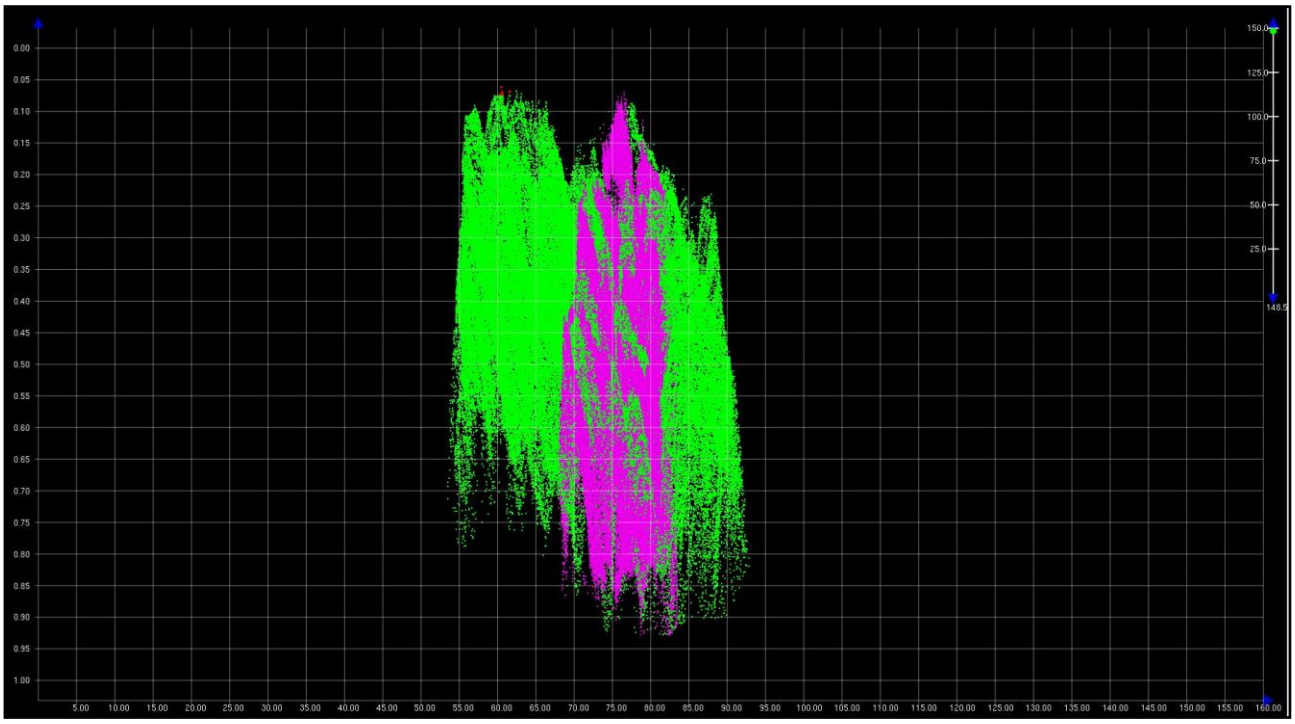

Figure 18 Subset image of the sand bank which rises to 0.07 m LAT observed

Observation 04

Sand bank rising to 2.5 m LAT observed outside the 5 m contour. Occurs at 53-09-48.36 N 004-15-26.80 W. The same sand bank also rises to 3.4 m LAT observed in an area charted at 47 in the same area.

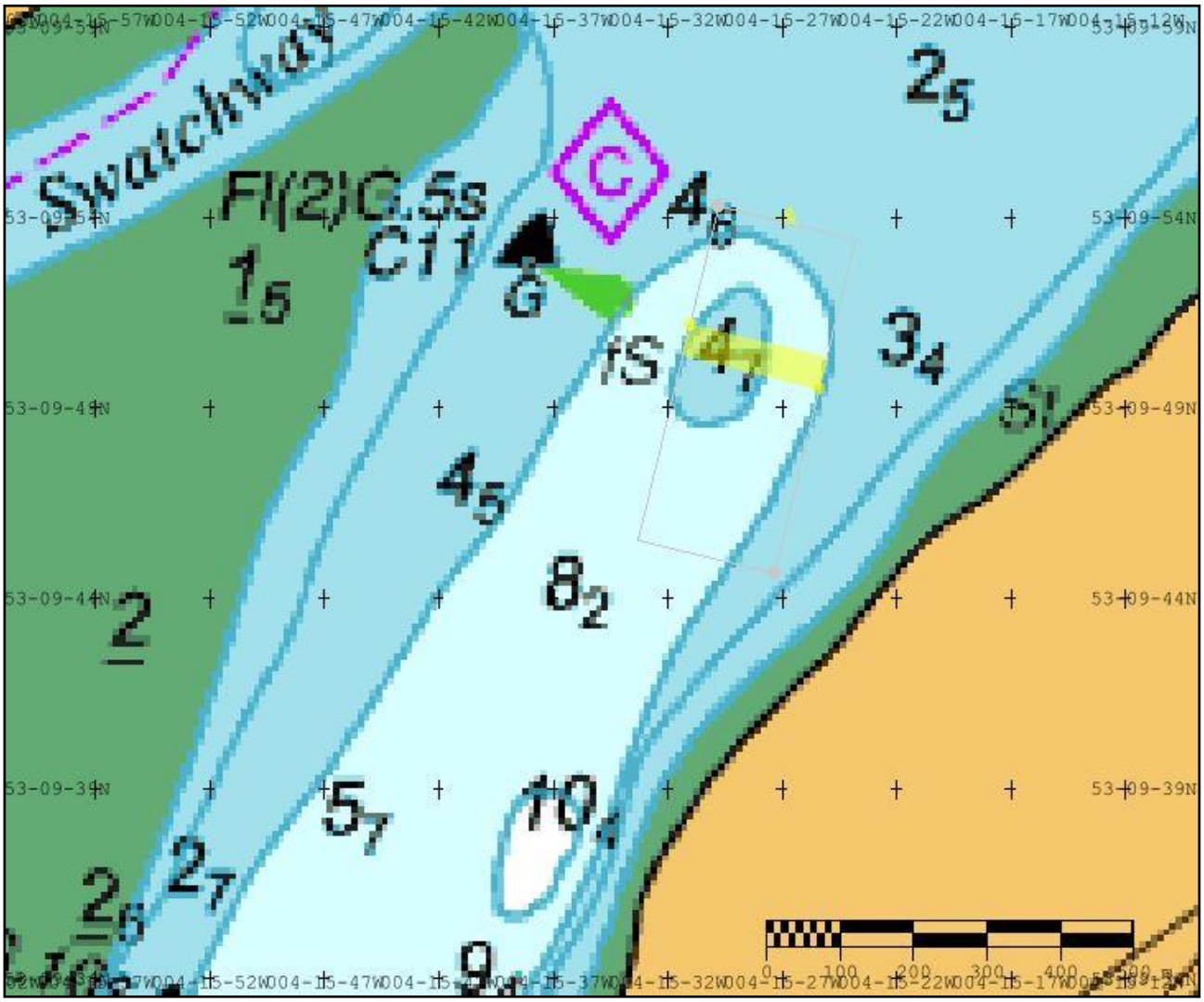

Figure 19 Chart details in area where sand bank rises to 2.5 m LAT observed and 3.4 m LAT observed

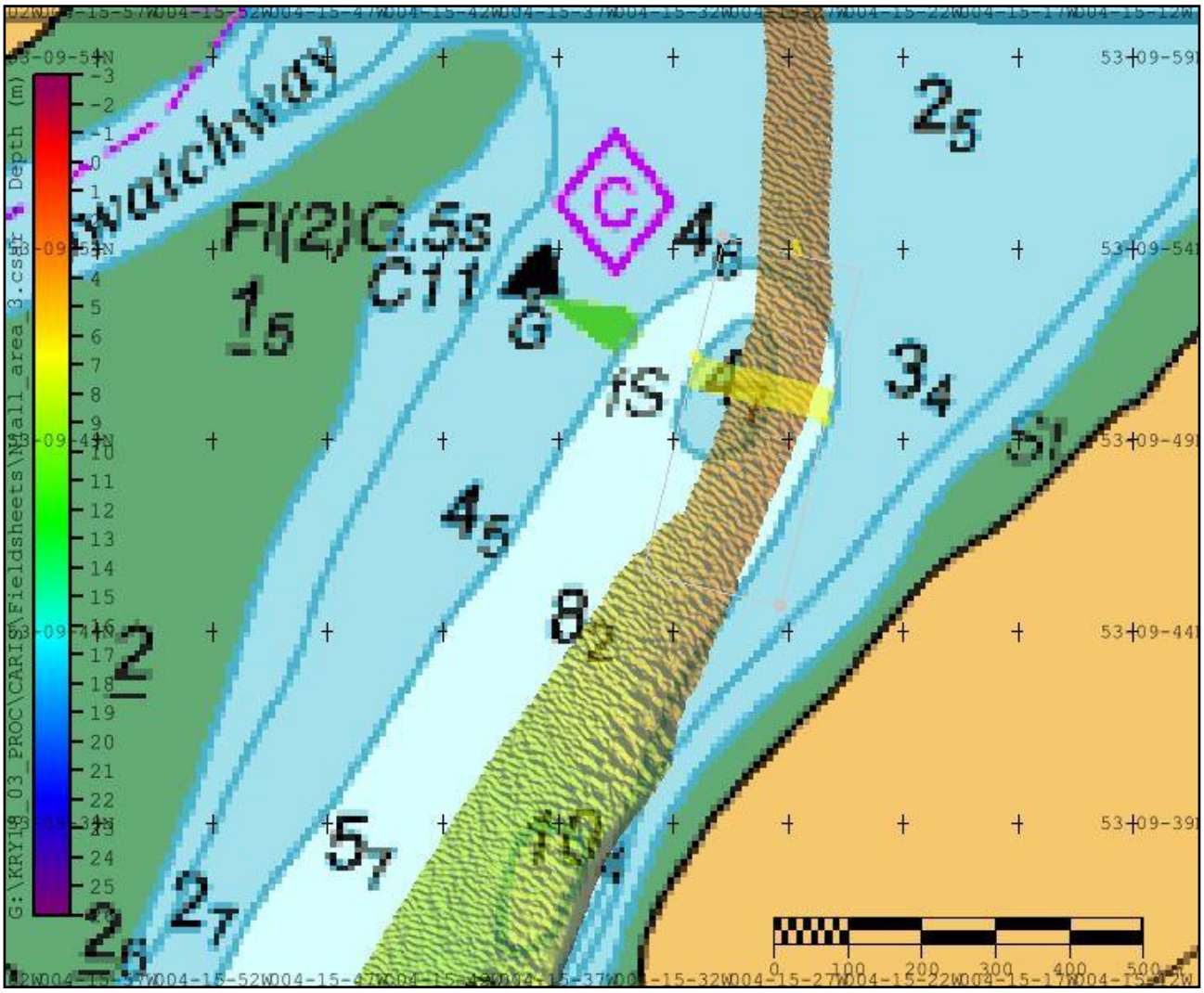

Figure 20 Image showing the sand bank which rises to 2.5 m LAT observed and 3.4 m LAT observed

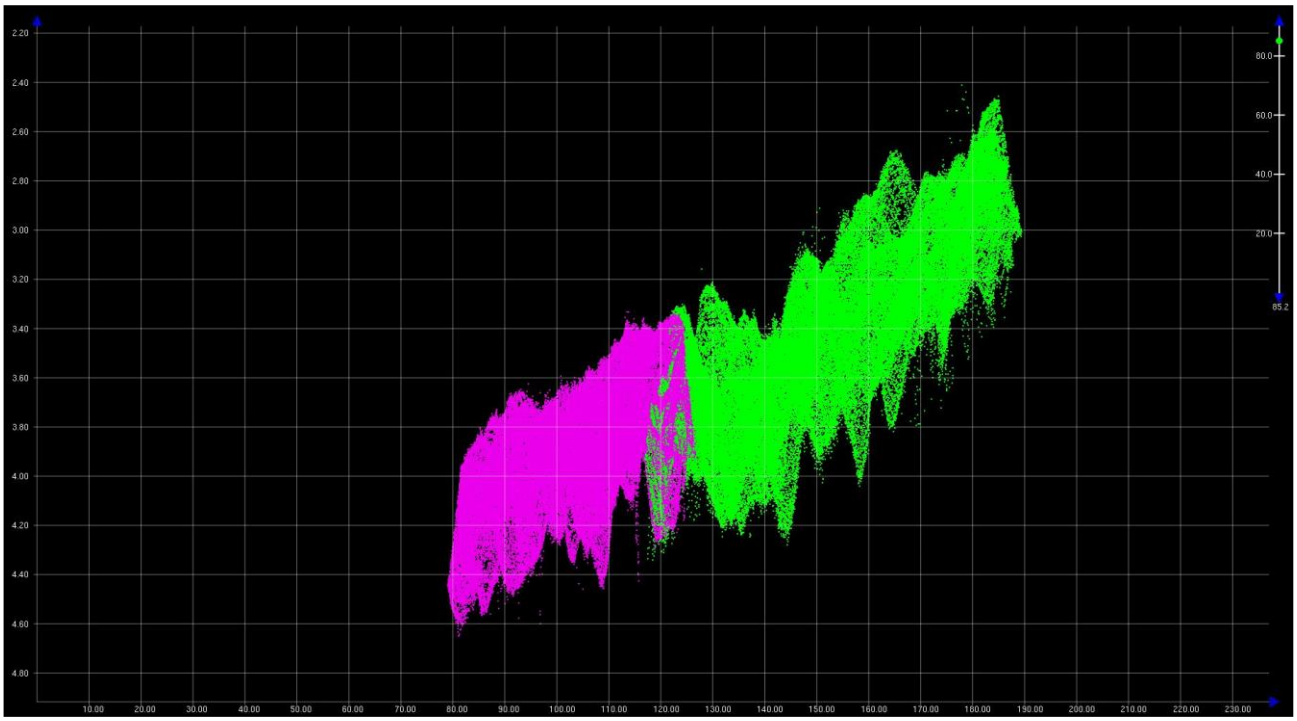

Figure 21 Subset view showing the sand bank rises to 2.5 m LAT observed (green line) and to 3.4 m LAT observed (pink line)

Observation 05

Sand bank rising to 0.10 m LAT observed. Occurs at 53-08-18.93 N 004-17-51.30 W. There is a drying area marked on the chart for the sand bank but it looks like the bank has moved. I will show a number of locations in the area as chart is wrong in a number of areas. The area marked as drying has almost 3 m LAT observed.

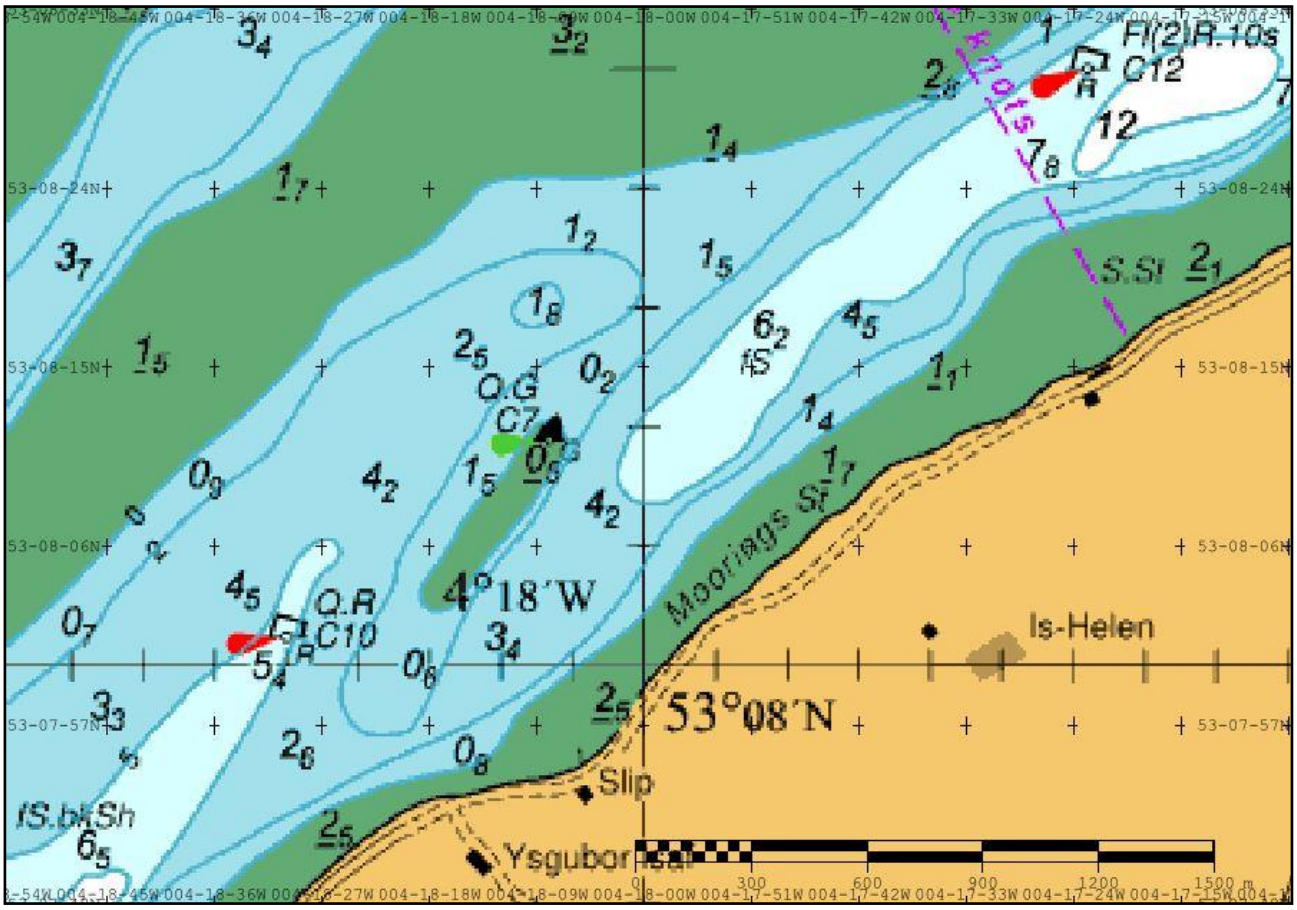

Figure 22 Chart details in the area of the sand bank

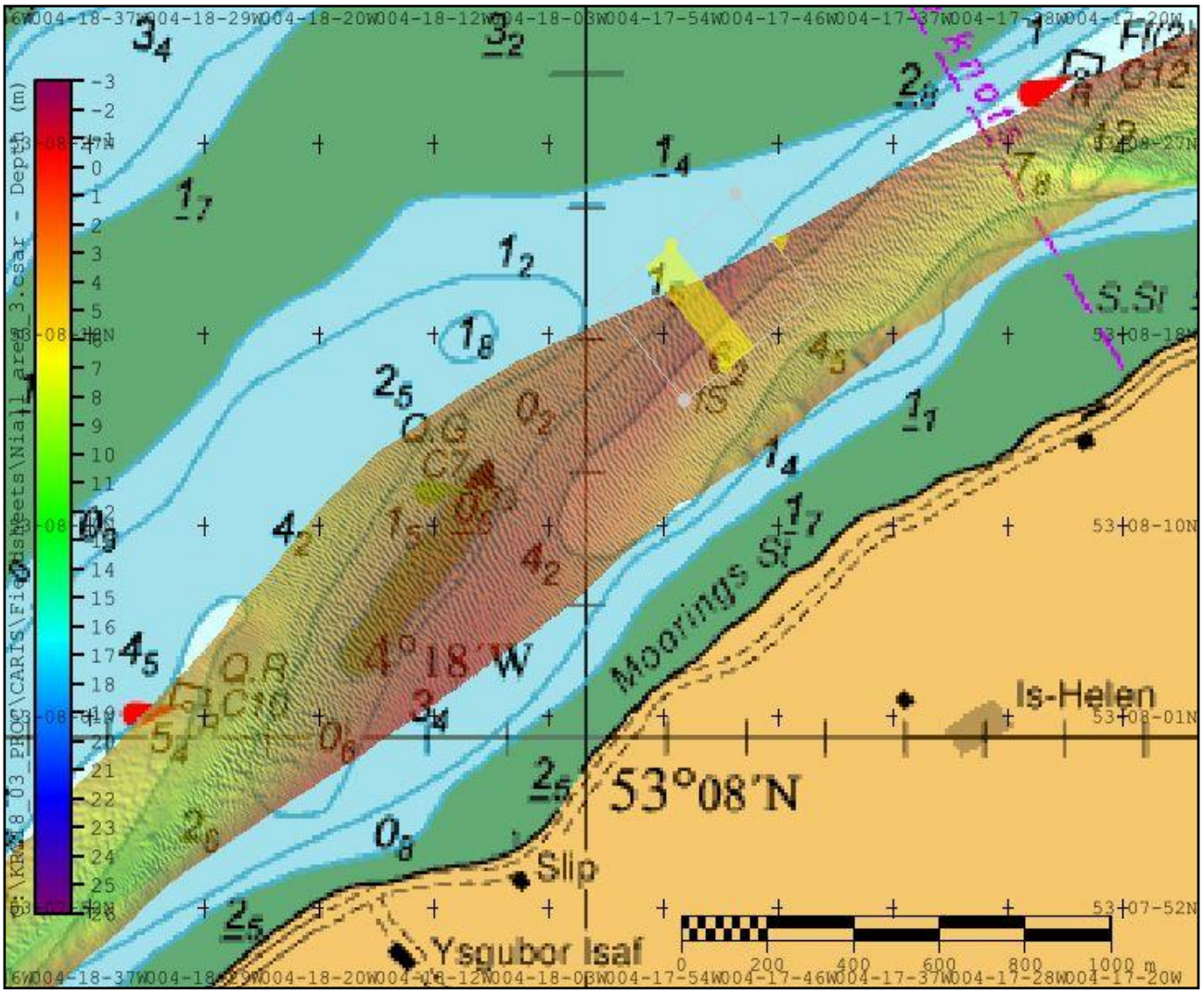

Figure 23 Sand bank which rises to 0.1 m LAT observed highlighted by yellow subset rectangle

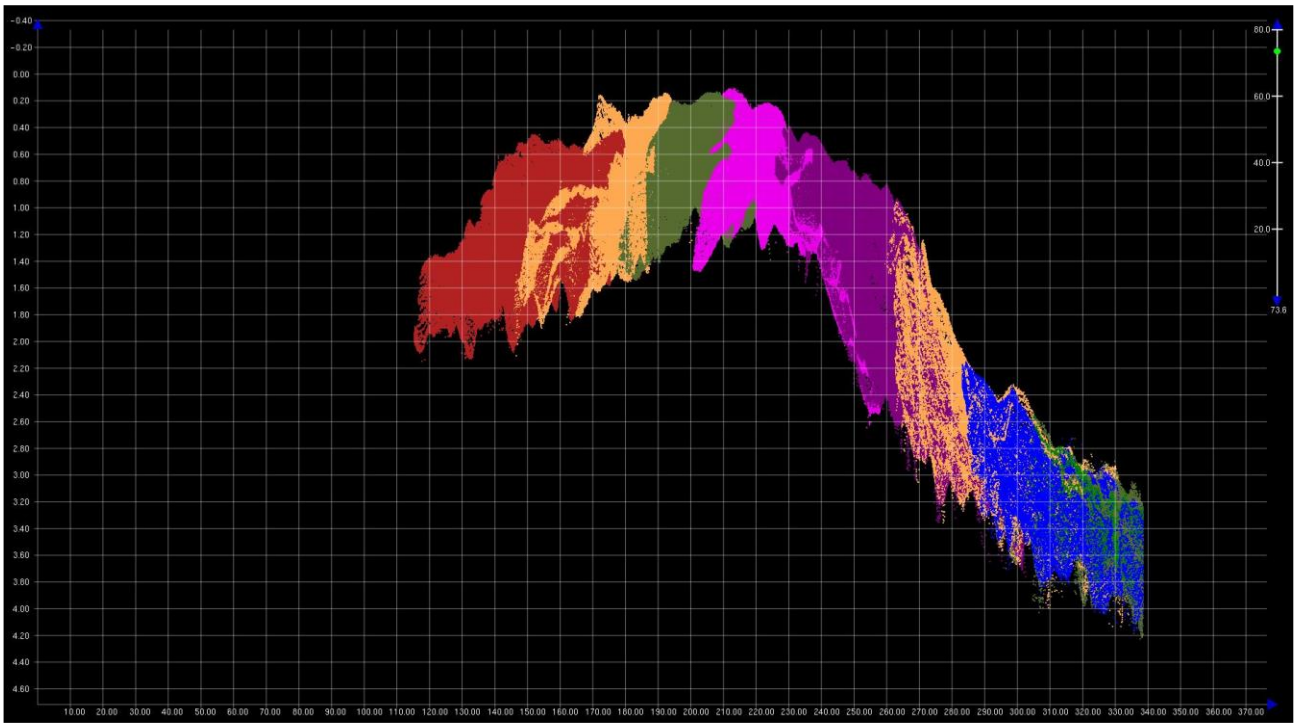

Figure 24 Subset view of the sand bank rising to 0.1 m LAT observed

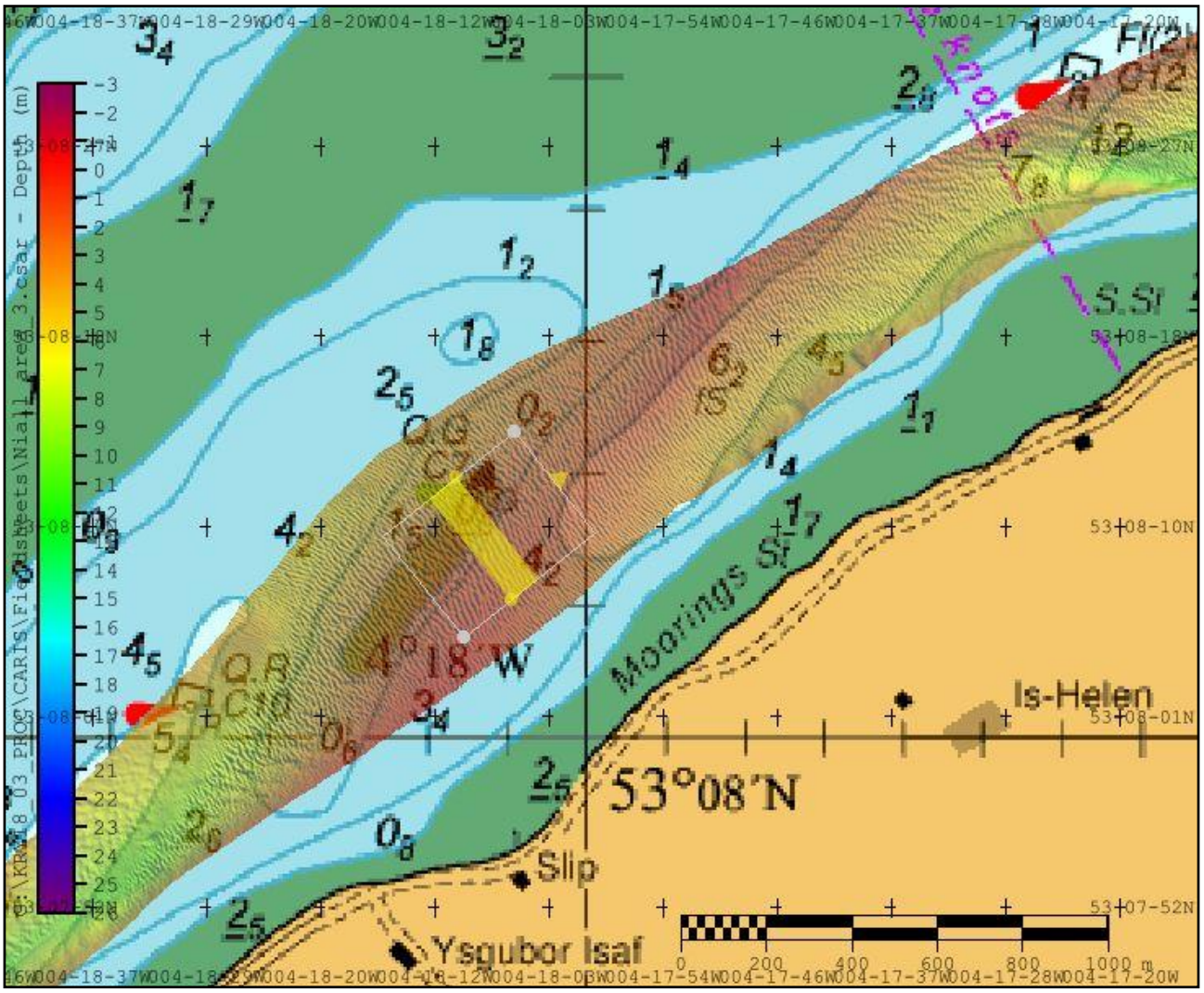

Figure 25 Subset rectangle showing sand bank south east of area marked as drying on chart

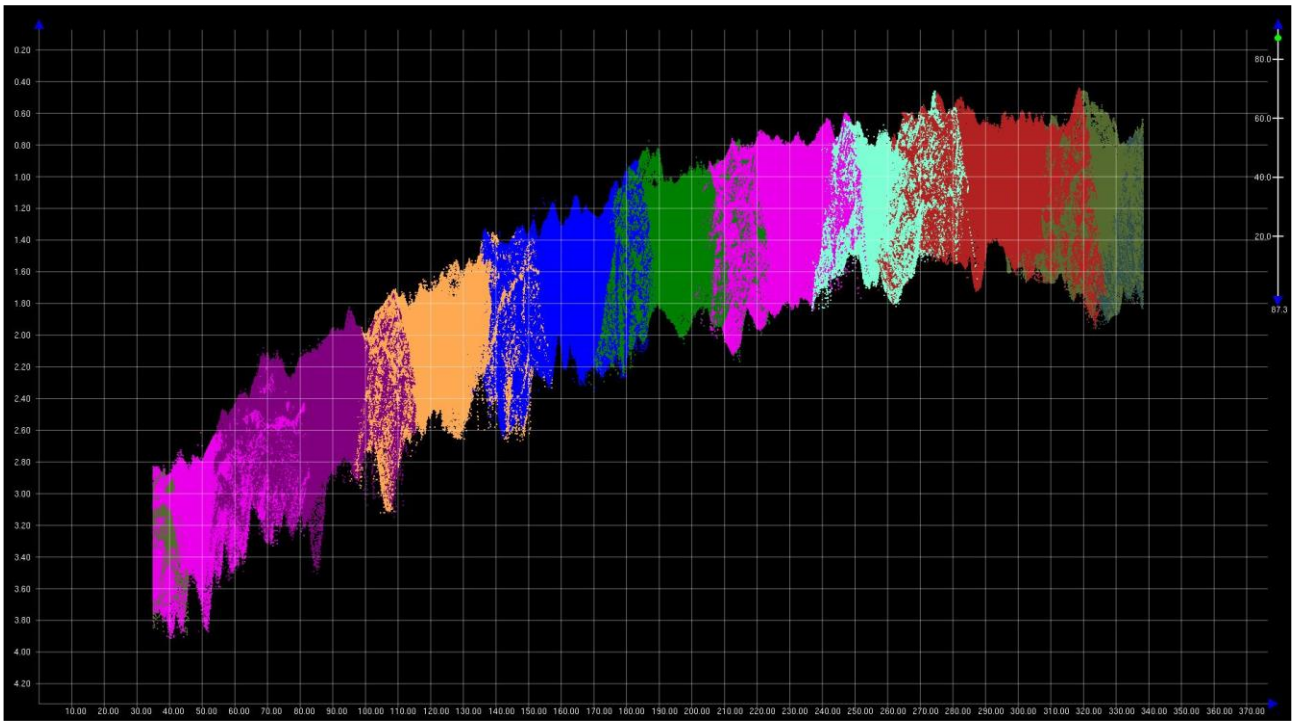

Figure 26 subset view of figure 25 where left side of image is over drying area on chart but has 1-2 m of water and to the right rising to 0.5 m LAT observed

Observation 06

Sand bank rising to -0.4 m LAT observed (Drying) just outside area marked as drying heights. Occurs at 53-07-07.52 N 004-24-04.92 W. Just south of middle sands drying area.

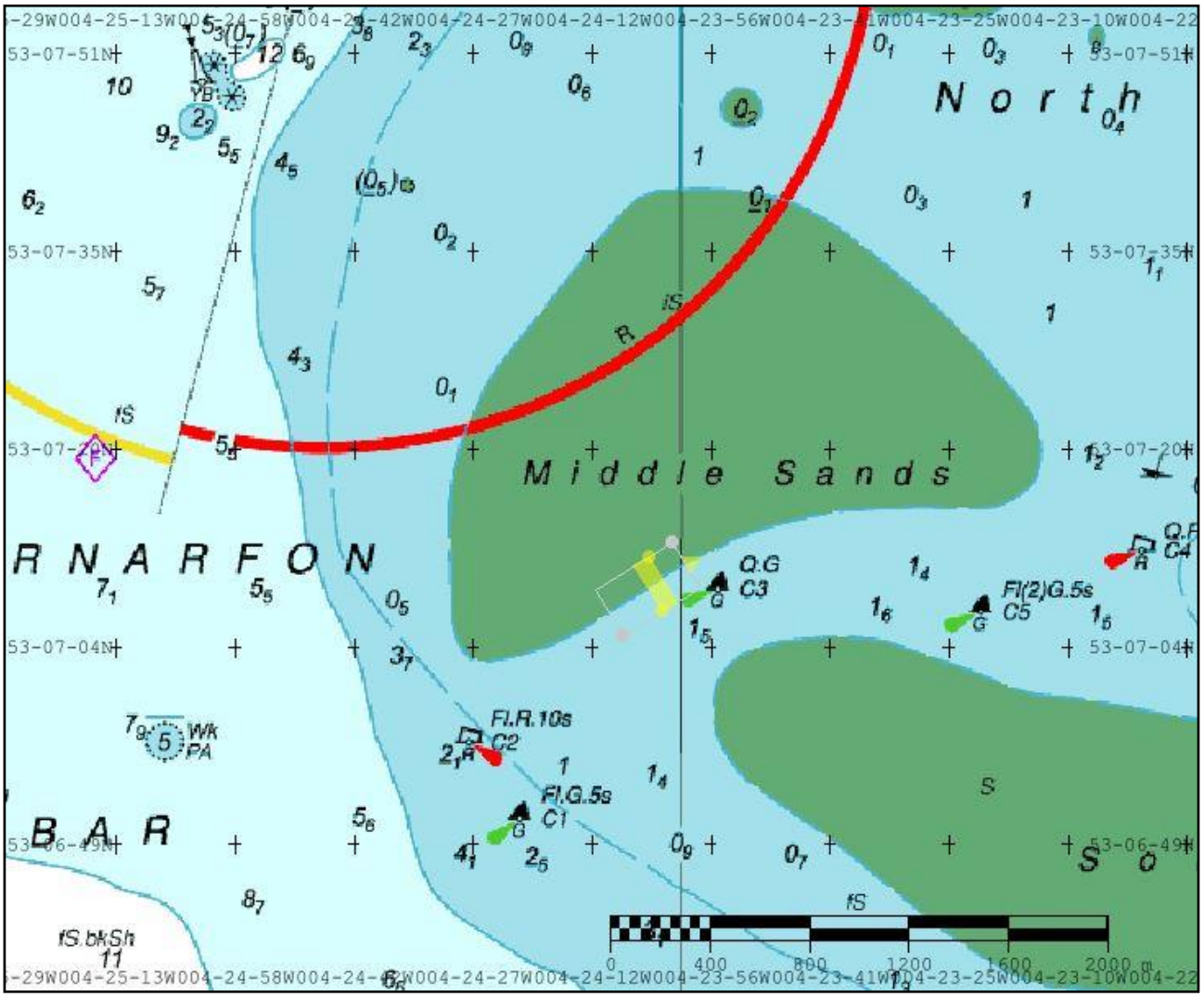

Figure 27 Chart details in area with sand bank rising to -0.4 m LAT observed just off drying area called Middle sands

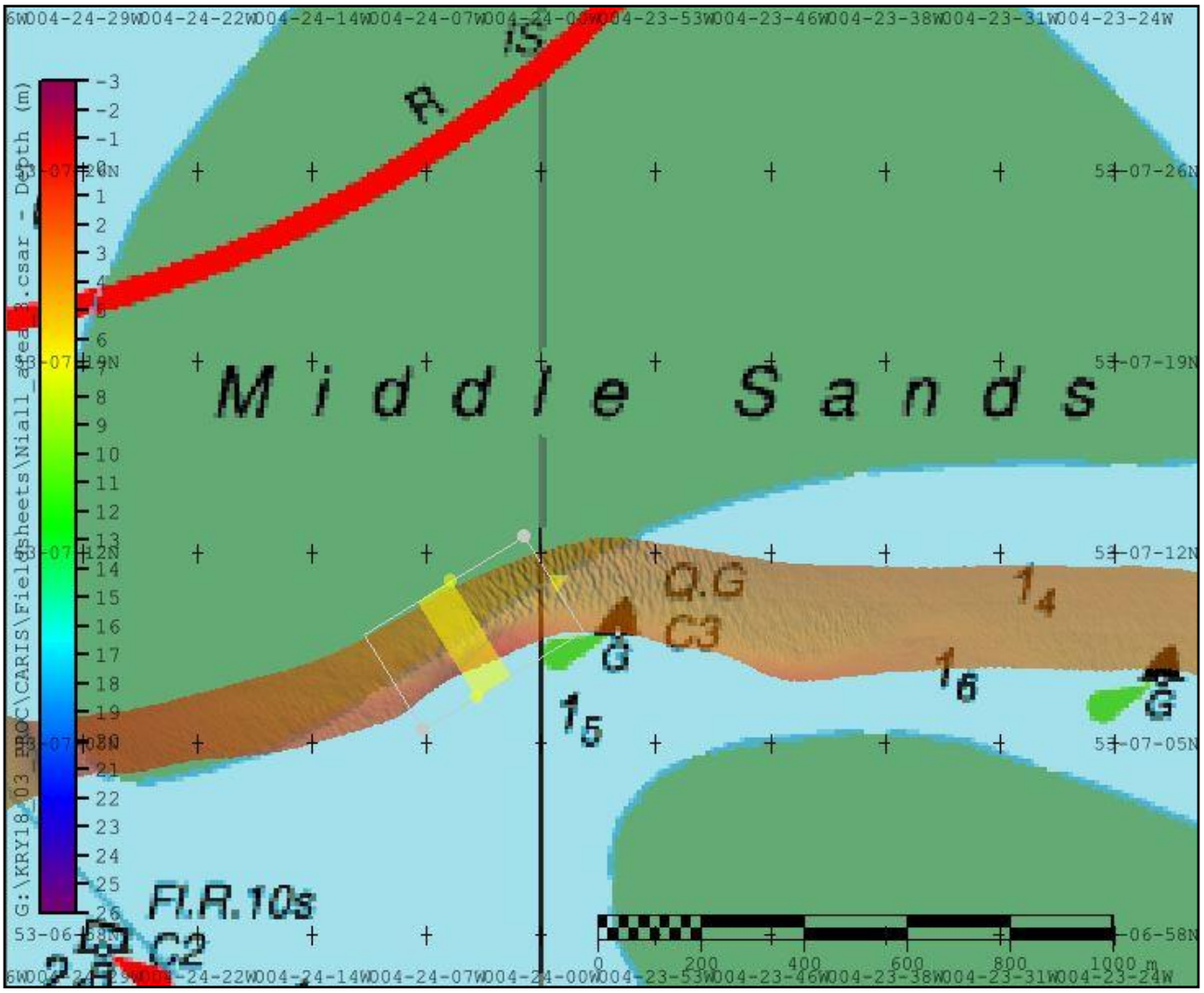

Figure 28 sand bank highlighted by yellow subset rectangle

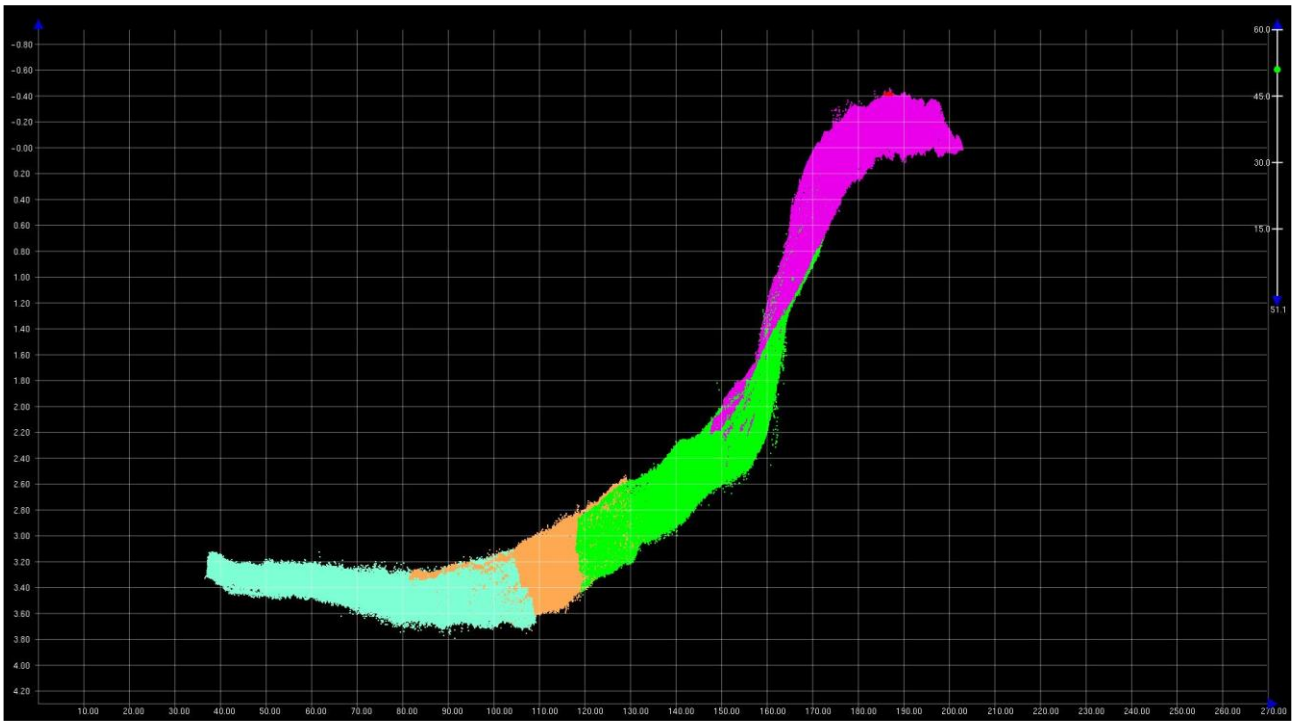

Figure 29 Subset view showing sand bank rising to -0.4 m LAT observed

Observation 07

Rocky shoal rising to 4 m LAT observed in area charted to 10 m. Occurs at 53-07-48.98 N 004-25-10.79 N. Approx. 575 m south west of Llanddwyn Island.

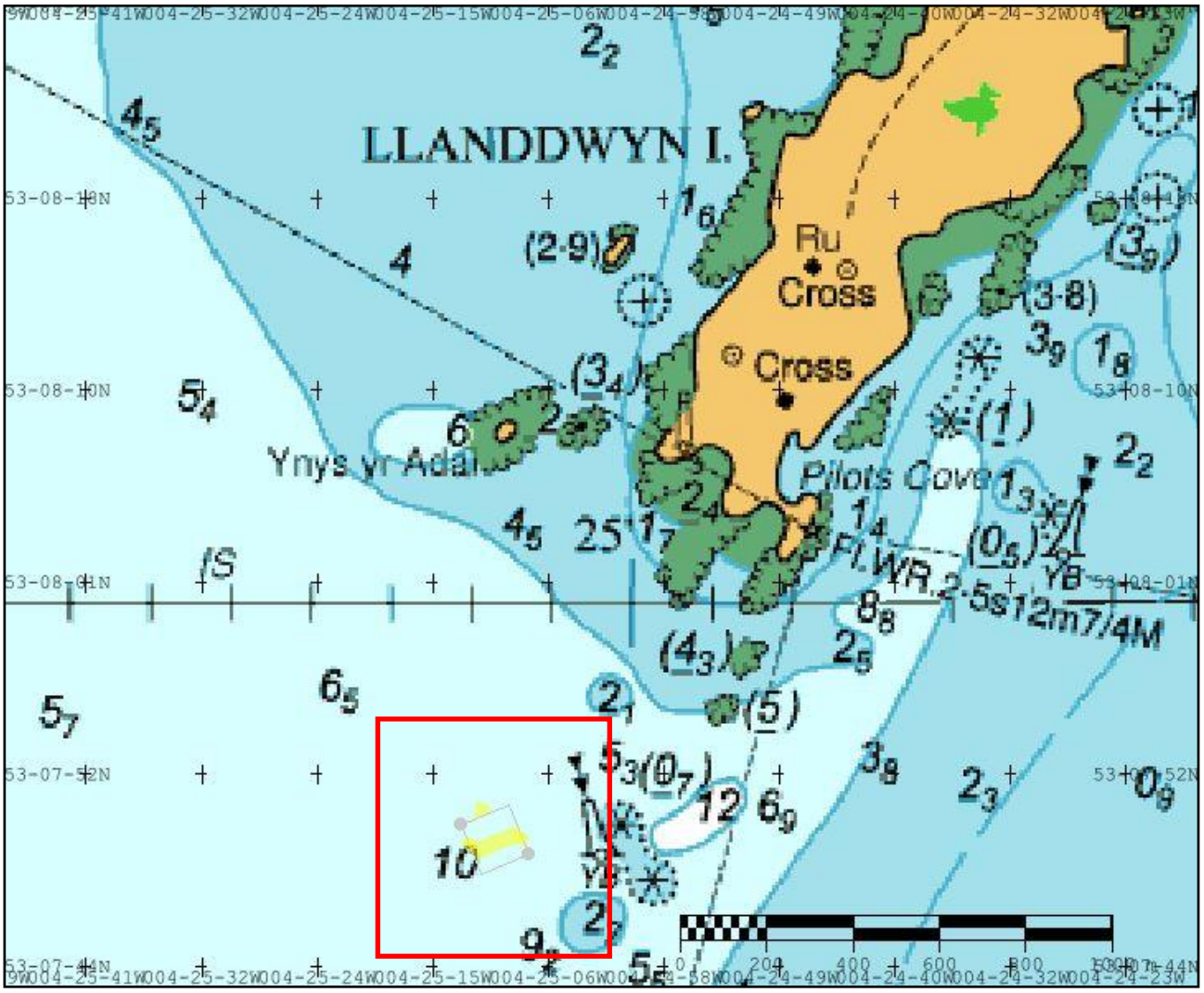

Figure 30 Chart details around shoal which is highlighted by yellow subset rectangle and red square

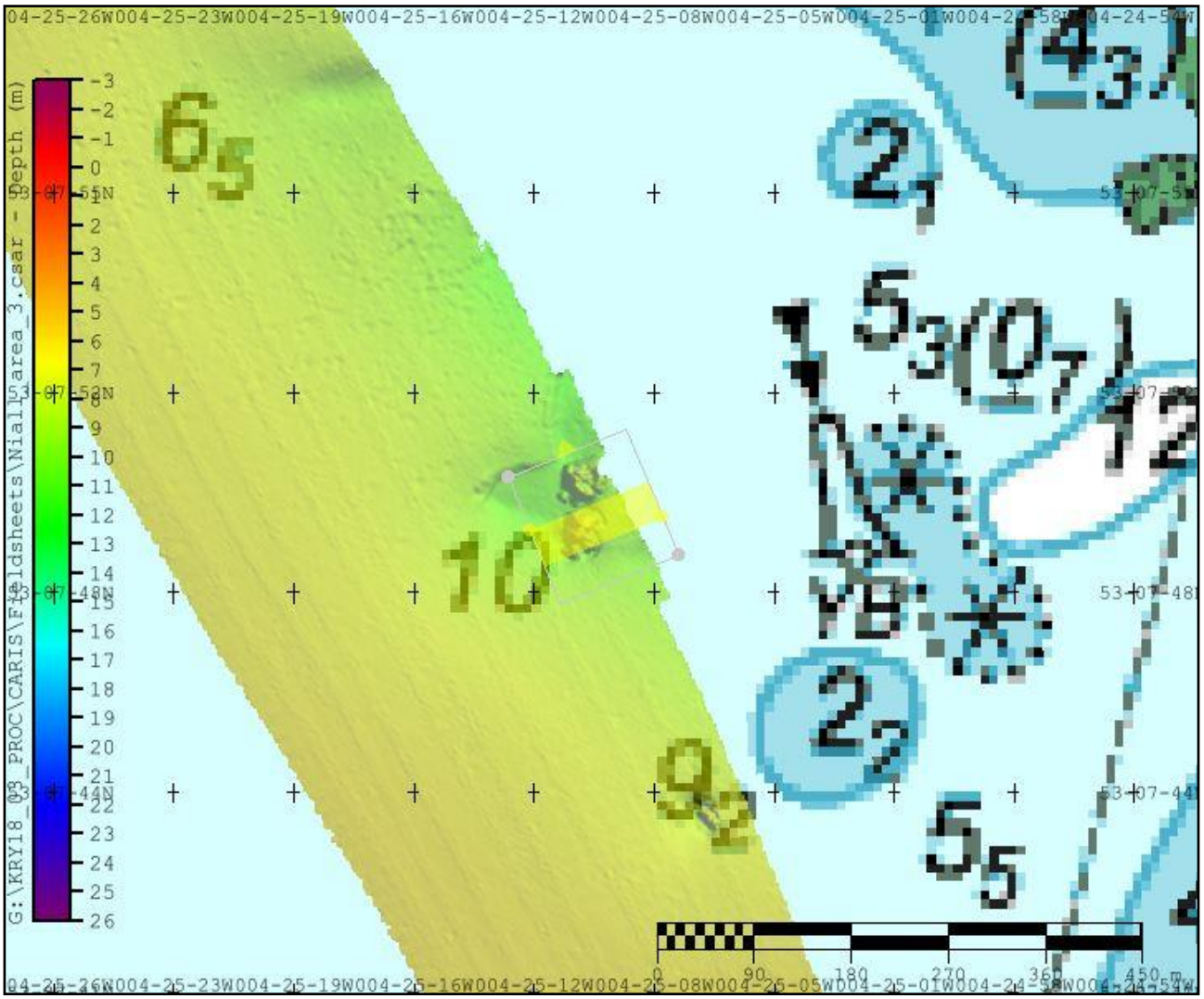

Figure 31 Rocky shoal with subset rectangle

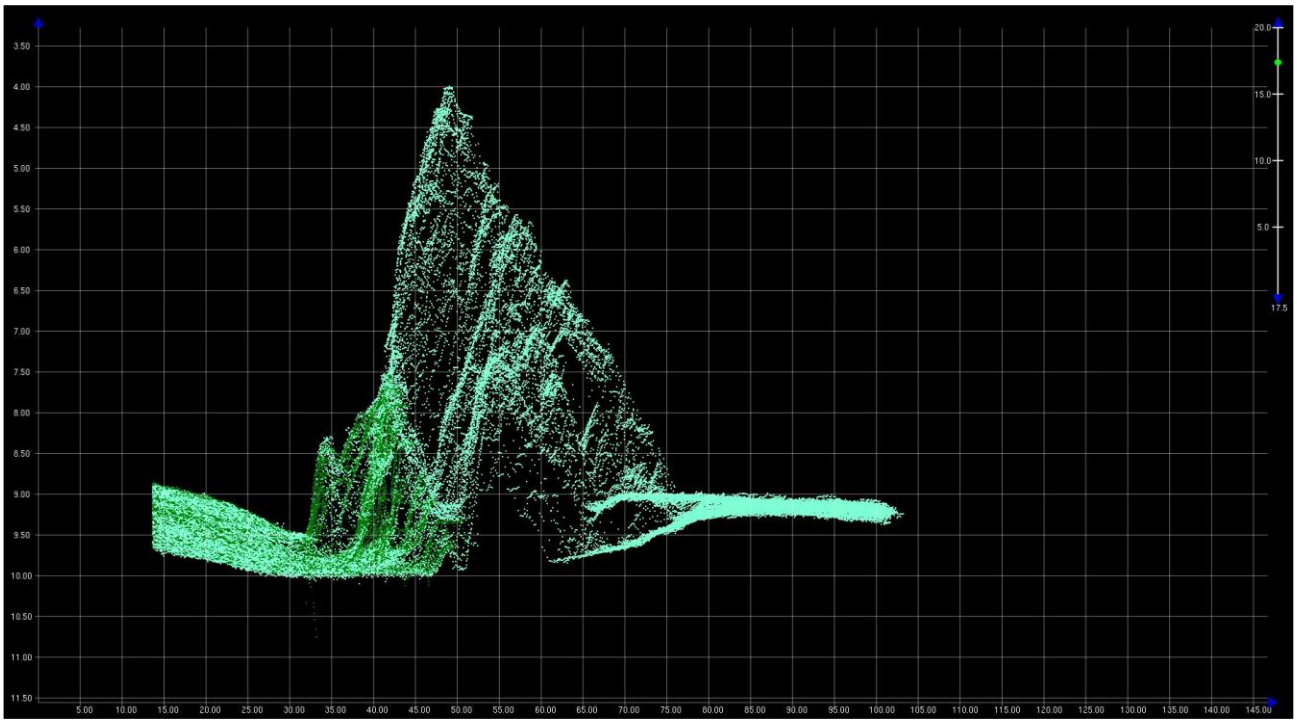

Figure 32 Subset view of rocky shoal rising to 4 m LAT observed

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

CHERISH
Newid Hinsawdd a Threftadaeth yr Afordir
Climate Change and Coastal Heritage
Athrú Aeráide agus Oidhreacht Chultúrtha

EU Funds: Ireland Wales Programme 2014-2020

Annex 4

Marine Mammal Observation Report – Anglesey, Wales Survey 2018 KRY18_03

Document Information

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Approved By	Date	Comment

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Ver. No.	Ver. Date	Comment	Revised By

Executive Summary

This report details marine mammal observation work conducted on the R.V. Keary during the CHERISH seabed survey of Anglesey, Wales carried out in the month of August 2018. Survey operations described in this report imply the use of vessel mounted multibeam, single beam & sub-bottom profiler acoustic equipment installed on the Irish state research vessel R.V. Keary. MMO field work and reporting were conducted with due consideration for the "*JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys",* documentation issued in August 2017 by the Joint Nature Conservation Committee (JNCC). Operations in Anglesey were not subject to licence conditions however due care was taken by the operations team to ensure that the guidance offered in the JNCC documentation was implemented. In a pre-season risk assessment categorizing risk to marine mammals both areas were deemed to be of low-medium risk for cetaceans.
Pre-start up watches were carried out by the designated MMO for at least half an hour prior to system start-up and generally from when the vessel crews came on duty. System start-up was performed at all times while alongside and always more than 20 minutes prior to cast-off / departure. Survey operations took place in the Anglesey area between the 8th and the 22nd August 2018. One recorded cetacean sighting was made during this time on the 22nd of August with details being provided in Appendix A: Marine Mammal Observation Forms of this report.

Date/Time	Sighting	Species	No.	Latitude	Longitude	Distance	Water Depth
22/08/2018 10.55	1	Common Seal	~20	53 23' 00.0N	04 15' 00.00W	~30m	0-10m

All cetacean sightings occurred while the vessel was underway with systems fully operational and no operational responses were deemed necessary or taken. The Common Seals remained in their locality and did not appear to move or alter their behaviour in response to the presence of the vessel.

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APPENDIX A: MARINE MAMMAL RECORDING FORM – COVER PAGE 6

1. Survey Vessel / MMO Platform

The CHERISH project utilised one survey vessel, operated by GSI, in the implementation of survey work in CHERISH Anglesey, Wales in 2018 - R.V. Keary.

R.V. Keary

The Irish state research vessel R.V. Keary is an aluminium catamaran designed for near shore survey work. She is ideally suited in this role due to her stable twin hull construction, shallow draft, retractable equipment pod and hydraulically operated A-Frame and winch. The R.V. Keary is typically crewed by a team of 3 individuals. Table 7 provides information on her design specifications and survey equipment on board.

Figure 1: R.V. Keary

Specification / System	Information
Length OA	15.5 m
Length (hull)	14.6 m
Beam (moulded)	5.6 m
Draught	1.9 m
Draught with pod deployed	2.4 m
Engines	2 x Cummins QSC 8.3 – 500 INT
Power output	368 kW/2600 RPM/Triple Phase
Transit Speed / Survey Speed	22 knots / 7.5 knots
Fuel	2000 lt Diesel
Generator	Cummins Onan 13.5 kva
Max passenger and crew	12 persons
Passenger Licence	P5
MBES	Kongsberg Simrad EM2040
SBES	Kongsberg Simrad EA400
Subbottom Profiler	Edgetech 3200XS Chirp
R/T SV	AML smart probe (pod mounted)
CTD/SVP	Valeport Mini SVP
Sparker	Geo-Resources Geo-Spark 200
Positioning System and IMU	POS-MV 320
DGPS	Hemisphere RTCM DGPS
Sediment Samplers	Duncan & Associates Day and Hand grabs
USBL	Sonardyne Scout
SSS	Edgetec 4200

Table 1: R.V. Keary Vessel Specifications

2. Acoustic Equipment

Acoustic Survey Equipment – R.V. Geo			
Equipment	**Model**	**Deployment**	**Company**
Multibeam Echo Sounder	Kongsberg Simrad EM2040	Retractable Pod	Kongsberg https://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/C75143F8AA145B48C12575E500276CA4?OpenDocument
Single Beam Echo Sounder	Kongsberg Simrad EA400	Retractable Pod	Kongsberg https://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/C75143F8AA145B48C12575E500276CA4?OpenDocument
Subbottom Profiler	Edgetech 3200XS Chirp	Retractable Pod	Edgetech https://www.edgetech.com/products/sub-bottom-profiling/

Table 2: Acoustic Equipment operated on board the R.V. Keary

3. Guideline and Licence Implementation

Prior to the commencement of the year's survey operations, a briefing was given to senior INFOMAR survey personnel on the nature of the guidelines for multibeam, singlebeam and sub-bottom profiler surveys in enclosed bays, inlets and estuaries. Where applicable, SAC extents were input to planning software. Licence conditions and the practical aspects of their implementation were discussed with the senior scientist on site. Copies of the DAHG Guidance for underwater sound sources (Jan 2014) and JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (Aug 2017) were available on board all survey platforms and licences were circulated to the Party Chief tasked with co-ordinating survey operations. The party chief ultimately took responsibility for collating all sightings and MMO related activity during INFOMAR operations while qualified crew members on each vessel acted in the role of marine mammal observer and all crew members were involved in maintaining a watch for cetaceans.

4. Soft Start Procedure

Multibeam echosounder soft starts were carried out as required. Where possible a ramp up of system power was utilised however, a ramp up of power is not possible with all multibeam / singlebeam systems, so as a recommended alternative, a soft start consists of switching power on and off during the soft start time period (20 minutes)

5. Survey Operations

Survey operations on board the INFOMAR inshore survey fleet operated by the Geological Survey of Ireland are carried out during daylight hours. This fact necessitates a return to a secure berth or mooring at the end of each day's operations. Furthermore, the requirement to start up and shut-down survey equipment at the beginning and end of each work day, leads to a slightly different set of operating procedures than is used further offshore on coastal survey vessels which operate 24 hour days.

This manner of operating has the advantage of having sufficient daylight for the MMO to locate and identify marine mammals while survey systems are being operated, however it also requires that the systems are started up correctly each day whereas an offshore platform typically operates the sound source for days at a time. The requirement to re-start the system each day has been addressed by, whenever possible, starting survey systems while stationary and alongside prior to departure. This tackles the need to begin operations at the innermost point of the survey area each day, however visibility can be restricted if the vessels are in port. While moored, visibility generally is unaffected. Survey equipment on each platform is online for a minimum of 20 minutes prior to departure each day. When long transits are necessary and the equipment must be switched off and retracted, the soft start is carried out when the vessel arrives at the survey site.

INFOMAR survey operations in Anglesey were implemented on board the R.V. Keary between the 8th and 22th August 2018. The vessel was based in both Victoria Dock and the Prince Madog Birth at Prince Quay in Menai Bridge and returned there each evening throughout the duration of the survey. Casual observations were maintained in the wheelhouse and back-deck by all survey crew members throughout the operation.

The official marine mammal recording forms Anglesey are presented in Appendix A. It should be noted that the form titled "Marine Mammal Recording Form – Operations" is designed for seismic rather than multibeam and sub-bottom profiler surveys. Several hundred multibeam lines were acquired on this survey and it is not possible to enter the

start and end of line times for each line. It is also not necessary to enter the start and end of each line as with multibeam and sub-bottom profiler there is no reduction in power between survey lines. Data and time of start of first survey line after start up were entered and date and time of end of last survey line before power off were entered.

Chapter 2 APPENDIX A: MARINE MAMMAL RECORDING FORM – COVER PAGE

Regulatory reference number (e.g. DECC no., MMS permit no., OCS lease no., etc.)	**Country** Wales	**Ship/ platform name** **R.V. Keary**
Client **DCCAE**	**Contractor** **CHERISH/GSI**	**Survey type** ☑ site ☐ 4C ☐ 2D ☐ VSP ☐ 3D ☐ WAZ ☐ 4D ☐ other ☐ OBC
Start date **08/08/2018**	**End date** **22/08/2018**	

Number of source vessels **1**	**Type of source** (e.g. airguns) **Multibeam**	**Number of airguns** (only if airguns used) **N/A**	**Source volume** (cu. in.)
Source depth (metres) **0.7m**	**Frequency** (Hz) 400kHz	**Intensity** (dB re. 1µPa or bar metres) 210 (MBES)	**Shot point interval** (seconds) Approx. 0.1 sec (MBES)
Method of soft start ☐ increase number of guns ☐ increase pressure (where permitted) ☐ increase frequency (where permitted) ☑ other			

Visual monitoring equipment used (e.g. binoculars, big eyes, etc.)	**Magnification of optical equipment** (e.g. binoculars)	**Height of eye** (metres)	**How was distance of animals estimated?**
Binoculars	**7 x 50**	**3m**	☑ by eye ☐ with laser rangefinder ☐ with rangefinder stick/ calipers ☐ with reticle binoculars ☑ by relating to object at known distance ☐ other
Number of dedicated MMOs **1**	**Training of MMOs** ☑ JNCC approved MMO induction course for UK waters ☐ PSO training course for the Gulf of Mexico ☑ MMO training course for Irish waters ☐ other ☐ none		

Was PAM used? ☐ yes ☑ no	**Number of PAM operators**
Description of PAM equipment	
Range of PAM hydrophones from airguns (metres)	**Bearing of PAM hydrophones from airguns** (relative to direction of travel)
	Depth of PAM hydrophones (metres)

MARINE MAMMAL RECORDING FORM - OPERATIONS

Regulatory reference number KRY18_03 Anglesey **Ship/ platform name**: R.V. Keary
(e.g. DECC no., MMS permit no., OCS lease no., etc.)

Complete this form every time the airguns are used, including overnight, whether for shooting a line or for testing or for any purpose.
Times should be in UTC, using the 24 hour clock.

Date	**Reason for firing** l = line t = test x = test followed immediately by line	**Time soft start/ ramp-up began**	**Time of full power**	**Time of start of line**	**Time of end of line**	**Time of reduced output** (if relevant)	**Time airguns/ source stopped**	**Time pre-shooting search began**	**Time search ended**	**Time PAM began**	**Time PAM ended**	**Was it day or night in period prior to firing?** d = day n = night w = dawn k = dusk	**Was any mitigating action required?** (yes/ no)
08/08/2018	L	17:10	17:30	17:30	19:00	N/A	19:00	14:45	19:20	N/A	N/a	D	No
09/08/2018	L	07:20	07:40	07:40	18:10	N/A	18:10	07:00	18:25	N/A	N/a	D	No
10/08/2018	L	06:20	06:40	06:40	15:00	N/A	15:00	06:00	18:20	N/A	N/a	D	No

11/08/2018	L	10:40	11:05	11:05	13:50	N/A	13:50	08:30	14:05	N/A	N/a	D	No
12/08/2018	L	08:40	09:00	09:00	17:20	N/A	17:20	08:00	18:45	N/A	N/a	D	No
13/08/2018	L	07:20	07:40	07:45	13:35	N/A	13:35	07:00	13:50	N/A	N/a	D	No
14/08/2018	L	10:00	10:20	10:25	14:00	N/A	14:15	08:10	17:00	N/A	N/a	D	No
15-19/08/2018	No Ops												
20/08/2018	L	06:30	07:00	07:00	17:50	N/A	17:50	05:45	19:45	N/A	N/a	D	No
22/08/2018	L	10:00	10:20	10:20	13:30	N/A	15:00	07:40	15:00	N/A	N/a	D	No

MARINE MAMMAL RECORDING FORM - EFFORT

Regulatory reference number: KRY18_03 **Ship/ platform name: R.V Keary**

Please record the following for all watches, even if no marine mammals are seen.									Start a new line on form if any one of these changes							
Date	**Visual watch or PAM v = visual watch p = PAM**		**Time of start of watch (UTC, 24hr clock)**	**Time of end of watch (UTC, 24hr clock)**	**Start position (latitude and longitude)**	**Depth at start (m)**	**End position (latitude and longitude)**	**Depth at end (m)**	**Speed of vessel (knots)**	**Source activity f = full power s = soft start r = reduced power (not soft start) n = not active**	**Wind direction**	**Wind force (Beaufort scale)**	**Sea state g = glassy (like mirror) s = slight (no or few white caps) c = choppy (many white caps) r = rough (big waves, foam, spray) or Beaufort sea states (0 - 7+)**	**Swell o = low (< 2 m) m = medium (2-4 m) l = large (> 4 m)**	**Visibility (visual watch only) p = poor (< 1 km) m = moderate (1-5 km) g = good (> 5 km)**	**Sunglare (visual watch only) n = no glare w = weak glare s = strong glare v = variable**

08/08/2018	**V**	**JB**	**14:45**	**19:20**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 08. 6' N 004° 16. 6' W**	**3**	**6**	**F**	**W**	**3**	**S**	**O**	**G**	**V**
09/08/2018	**V**	**JB**	**07:00**	**18:25**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 08. 6' N 004° 16. 6' W**	**3**	**6**	**F**	**SW**	**3-4**	**S**	**O**	**G**	**V**
10/08/2018	**V**	**JB**	**06:00**	**18:20**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 08. 6' N 004° 16. 6' W**	**3**	**6**	**F**	**S**	**3-5**	**S**	**M**	**G**	**V**
11/08/2018	**V**	**JB**	**08:30**	**14:05**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 08. 6' N 004° 16. 6' W**	**3**	**6**	**F**	**S**	**3-4**	**S**	**O**	**G**	**V**
12/08/2018	**V**	**JB**	**08:00**	**18:45**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 13. 5' N 004° 09. 5' W**	**3**	**6**	**F**	**SW**	**3**	**G**	**O**	**P**	**N**
13/08/2018	**V**	**JB**	**07:00**	**13:50**	**53° 13. 5' N 004° 09. 5' W**	**3**	**53° 13. 5' N 004° 09. 5' W**	**3**	**6**	**F**	**NW**	**3-4**	**S**	**O**	**P**	**N**
14/08/2018	**V**	**JB**	**08:10**	**17:00**	**53° 13. 5' N 004° 09. 5' W**	**3**	**53° 13. 5' N 004° 09. 5' W**	**3**	**6**	**F**	**W-SW**	**3-4**	**S**	**O**	**P**	**N**
15- 19/08/2018		**No ops**														

20/08/2018	**V**	**JB**	**05:45**	**19:45**	**53° 13. 5' N 004° 09. 5' W**	**3**	**53° 13. 5' N 004° 09. 5' W**	**3**	**6**	**F**	**W**	**1-2**	**G**	**O**	**M**	**V**
22/08/2018	**V**	**JB**	**07:40**	**15:00**	**53° 08. 6' N 004° 16. 6' W**	**3**	**53° 08. 6' N 004° 16. 6' W**	**3**	**6**	**F**	**SW**	**4-5**	**C**	**M**	**P**	**W-V**

Cetacean Sighting Record Form KRY18_03

Date 22/08/2018	**Time** (GMT) 10:55 **Duration**: 10 minute	**Survey Ref. No.** KRY18_03	**Sighting no.** 1

How did this sighting occur? (please tick)

While you were keeping a continuous watch for marine mammals	_
Spotted incidentally by you or someone else	Yes
Other (please specify)	_

Ship RV Keary Geolgical Survey of Ireland, Beggars Bush Haddington Road Dublin 4 cosantoirbradan@gmail.com	**Observer** James Barry
Location: Dulas Island, NE Anglesey, Irish Sea **Ship's position** (latitude and longitude) 53 23' 00.0N 04 15' 00.00W	**Water depth** (metres) 0-10
Species Common Seals	**Certainty of identification** *probable*
Estimated Length: <1.5-2 m (6 ft)	**Number of adults** ~10
Colour: Dark Grey	**Number of juveniles** ~10
Weather Moderate force 4-5 SW winds, Swell <2m, Rainy/overcast, Visibility Variable	**Photograph or video taken:** *No* **Optics Used**: None
Sighting Description: Colony of grey common seals to the bow of the vessel swimming around the island. Vessel continued on a north westerly course.	**Direction of travel of animals in relation to ship** Seals were swimming all around the east side of the island
Behaviour Surfaced intermittently and continued swimming and playing	**Direction of travelof animals** N/A

Activity of ship Multibeam Surveying	**Sonar Systems pinging** (when animals first seen) *Yes*	**Closest distance of animals from sonar head** (Record even if not pinging) ~ 30 m