

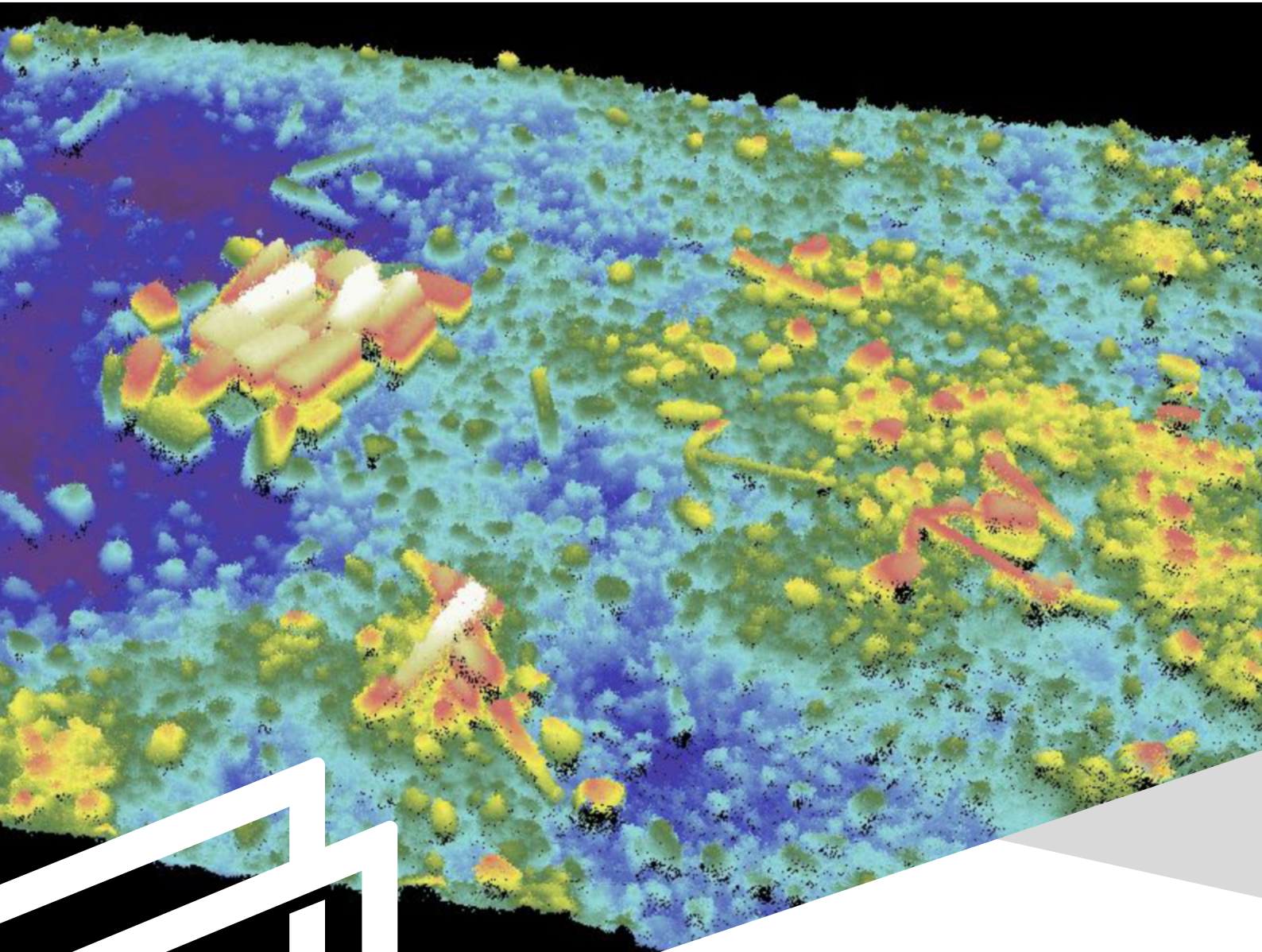


Rialtas na hÉireann  
Government of Ireland



Geological Survey  
Suirbhéireacht Gheolaíochta  
Ireland | Éireann

# Wales Marine Survey 2020



**CHERISH**

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



Comisiwn Brenhinol  
Henebion Cymru  
Royal Commission on the Ancient  
and Historical Monuments of Wales



Geological Survey Ireland is a division of the Department of the Environment, Climate and Communications

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Prepared By	Date	Comment
Kieran Craven	28 <sup>th</sup> June 2021	Consultant CHERISH Project, Rodinia Consulting Ltd
James Barry	28 <sup>th</sup> June 2021	Consultant CHERISH Project, Rodinia Consulting Ltd

Reviewed by	Date	Comment
David Hardy	29 <sup>th</sup> June 2021	
David Hardy	12 <sup>th</sup> July 2021	
David Hardy	27 <sup>th</sup> July 2021	

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Sean Cullen	28 <sup>th</sup> July 2021	Geological Survey Ireland

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# Executive summary

**Table 1: Survey Summary**

Survey Summary			
Survey Vessels:	R.V. Keary (GSI)	Survey Legs:	KRY20_03
Mobilisation Port:	Arklow, Co. Wicklow	Demobilisation Port:	Dun Laoghaire, Co. Dublin
Survey Area/s:	Cardigan Bay, Wales Caernarfon Bay, Wales	Survey Duration:	01/09/2020 – 19/09/2020
N Boundary: S Boundary: E Boundary: W Boundary:	<b>53.12437° N</b> <b>52.67900° N</b> <b>4.122334° W</b> <b>4.413649° W</b>	} WGS1984	
UKHO Admiralty Charts	<b>0002, 1121, 1123, 1410, 1411, 1970, 1971, 1972,</b>		
Key References			
Survey Statistics			
Minimum Water Depth (LAT):	<b>0 m above LAT</b>	Maximum Water Depth (LAT):	<b>15 m below LAT</b>
Area Covered (Km <sup>2</sup> ):	<b>25.6</b>	Survey Line Kilometres:	<b>914.4</b>
Operational (based on 24h days):	<b>KRY – 3d 20h</b>	Downtime (based on 24h days):	<b>KRY – 2d 08h</b>
Groundtruthing Stations:	0	Incidents to Report	0



# 1. Introduction

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## 1.1. Marine Survey Overview

This Report of Survey document represents survey work carried out by Geological Survey Ireland vessel RV Keary in CHERISH areas in Cardigan and Caernarfon Bays, Wales in 2020. Authorisation for the survey was received from the Maritime Policy Unit of the Foreign & Commonwealth Office (Ref 66/2020). 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 two sites in Cardigan and Caernarfon Bays for which the project required detailed bathymetric surveys (Sarn Badrig and Dinas Dinlle). Three main site types were targeted: reefs, headlands, and shipwrecks. Reefs for multibeam surveys included Sarn Badrig in Cardigan Bay, while headlands included Dinas Dinlle in Caernarfon Bay. The wreck of “The Bronze Bell off Tel Y Bont, Gwynedd” (hereafter “The Bronze Bell”) was selected due to its designated status. Headland bathymetry will be used to generate seamless onshore-offshore maps.

Multibeam surveying was 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 1<sup>st</sup> and 19<sup>th</sup> September 2020. 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 as appendices. Accordingly, when taken together with this Report of Survey document, the appendices form the overall CHERISH North Wales 2020 survey report

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.

Although every effort has been made to ensure the accuracy of the material contained in this report, complete accuracy cannot be guaranteed. Neither the Geological Survey Ireland nor the author accepts any responsibility whatsoever for loss or damage occasioned, or claimed to have been occasioned, in part or in full as a consequence of any person acting or refraining from acting, as a result of a matter contained in this report.

## 1.2. Geological Survey Ireland

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 the Environment, Climate and Communications.



### **1.3. The CHERISH Project**

The CHERISH (Climate, Heritage and Environments of Reefs, Islands and Headlands) Project is a 6 year (2017-2022) 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 €5.1 million through the Ireland Wales 2014-2020 European Territorial Cooperation 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](http://www.cherishproject.eu)





## 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 offshore of selected sites in North Wales, using a range of acoustic equipment. Bathymetry was to be acquired to IHO S-44 Order 1a Standard. One GSI vessel was mobilised for the survey: R.V. Keary.

### 2.2. Survey Area

The distribution of survey effort by R.V. Keary is shown in Figure 1 below, comprising of 25.6 km<sup>2</sup> at two locations.



Figure 1: Survey Coverage Polygons of RV Keary during KRY20\_03 and location of the “Bronze Bell” Wreck

### 2.3. Survey Team

2020 CHERISH survey operations off North Wales were crewed by a team comprised of contracted staff from the GSI. Table 2 below lists all personnel involved with these survey operations.

Table 2 : Survey team

Crew Member	Capacity	Organisation
Agust Magnusson	Vessel Master	GSI-Contract
Jess Murray	Data Processor/Surveyor	GSI-Contract



## 2.4. Survey Statistics

Operations tables for the 2020 CHERISH North Wales survey are provided along with an over-arching summary of activity conducted. Should an individual day by day breakdown be required, this information is contained in the digital DPR (Daily Progress Report) issued each day and within the final project data delivery.

Table 3 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.

**Table 3: Event Descriptor Breakdown**

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

**Table 4: KRY20\_03 Operations Summary**

	Stats: Hours	Stats: Days	Stats: Percentages
Port Call	230	9.59	47.95
Weather Standby	48	2.00	10.00
Standby	25	1.04	5.19
Transit	53	2.20	10.98
Data Acquisition	99	4.14	20.69
Downtime Vessel	2	0.10	0.50
Downtime Survey	0	0.00	0.00
Ground-truthing	0	0.00	0.00
Other	23	0.94	4.69
	Stats: Total Hours	Stats: Total Days	Stats: Total Percentage
	480	20.00	100



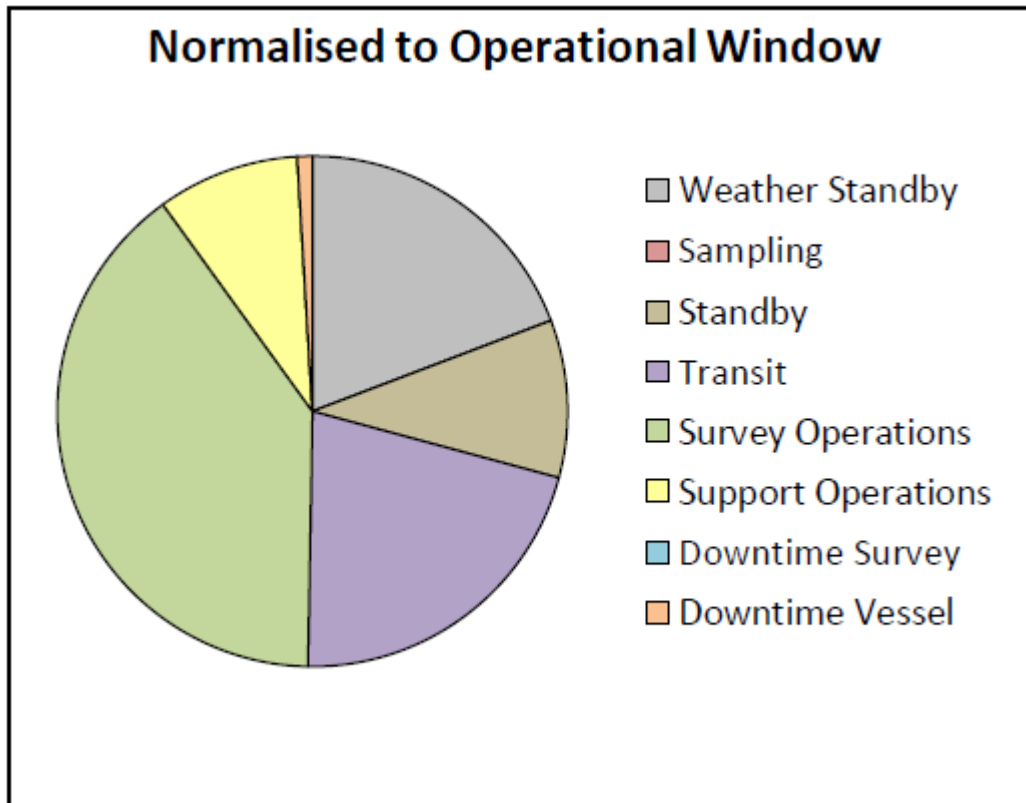


Figure 2: KRY20\_03 Survey Statistics Pie Chart normalised to Operational Window

Table 5: KRY20\_03 Operational Statistics

Survey Leg	Line Kilometres (km)	Area Covered (km <sup>2</sup> )
KRY20_03	914.4	25.6



## 3. Survey Systems and Setup

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### 3.1. Survey Platforms

The CHERISH project utilised one survey vessel, operated by GSI, in the implementation of survey work in North Wales in 2020 – the 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 3: R.V. Keary

**Table 6: R.V. Keary Vessel Specifications**

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 EM2040D
SBES	Kongsberg Simrad EA400
Subbottom Profiler	Edgetec 3200XS Chirp (pod mounted)
R/T SV	AML smart probe (pod mounted)
CTD/SVP	Valeport SWiFT SVP
Positioning System and IMU	POS-MV OceanMaster
DGPS	EGNOS Corrections
Sediment Samplers	Duncan & Associates Day and Hand grabs
USBL	Sonardyne Scout
SSS	Edgetec 4200

### 3.1.2. Survey Software Utilised

The table below provides details on the primary software tools utilised by survey vessel during the survey to North Wales. Further information is provided in Section 4 of this document under Survey Data Summary.

**Table 7: Software Utilised**

Survey Aspect	Vessel	Software
MBES Data Acquisition	R.V. Keary	Kongsberg SIS
Online Survey Planning	R.V. Keary	QPS QINSy
Online Navigation QC	R.V. Keary	Applanix POSview
SBES Data Acquisition	R.V. Keary	Simrad EA400
Shallow Seismic Data Acquisition	R.V. Keary	Edgetec Discovery
Data Processing	R.V. Keary	Applanix POSpac, QPS Qimera, Caris HIPS & SIPS
Survey Reporting and Statistics	R.V. Keary	Custom Excel Worksheets
SVP Data Acquisition	R.V. Keary	QPS QINSY & Datalog Express



## 3.2. Geodetic Parameters

**Table 8: Survey Geodetic Parameters (processed data)**

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 <sup>2</sup> )	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

## 3.3. Vessel Dimension Control

Vessel and equipment offsets and sensor mounting angles utilised during the course of the 2020 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 the RV Keary's 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 in 2019. These values were applied to survey systems using Kongsberg SIS and Applanix POSview software.

Values derived from the original dimension control survey were verified through standard calibration tests and refined where necessary.

**Table 9: R.V. Keary Installation Parameters**

<b>R.V. Keary Offsets (metres)</b>	<b>X (Stbd +)</b>	<b>Y (Bow +)</b>	<b>Z (Up +)</b>
MBES Reference Point	0.000 m	-0.000 m	0.000 m
EM2040 MBES Sonar Head 1 (Port)	-0.341 m	0.046 m	+0.087 m
EM2040 MBES Sonar Head 2 (Stbd)	0.352 m	0.041 m	+0.085 m
EM2040 TX	0.000 m	-0.051 m	-0.083 m
Waterline Value	-1.940 m		
<b>Installation Angles (degrees)</b>	<b>Roll</b>	<b>Pitch</b>	<b>Heading</b>
EM2040 MBES Sonar Head 1 (Port)	39.836°	-1.504°	-0.388°
EM2040 MBES Sonar Head 2 (Stbd)	-39.928°	-1.557°	1.240°
POS-MV IMU	0	0	0

**Table 10: R.V. Keary Installation Parameters Applied in POS-MV**

<b>R.V. Keary Applanix POS-MV Software (IMU as Origin)</b>			
<b>Heave &amp; Sensor 1 &amp; 2 Install Parameters.</b>	<b>Roll</b>	<b>Pitch</b>	<b>Heading</b>
Sensor 1 alignment angles (deg)	0.000	0.000	0.000
Sensor 2 alignment angles (deg)	0.000	0.000	0.000
	<b>X (Bow +)</b>	<b>Y (+ Stbd)</b>	<b>Z (+ Down)</b>
Sensor 1 lever arm in meters	0.110	0.004	0.990
Sensor 2 lever arm in meters	0.000	0.000	0.000
Centre of Rotation in meters	0.000	0.000	-1.300
<b>GAMS Install Parameters</b>			
Ant 1 – Ant 2 antenna separation (m)	3.289		
Ant 1 – Ant 2 baseline vector (m)	0.004	-3.289	-0.002
Heading error for calibration	0.350		
Ant 1 – Ant 2 azimuth correction	0.000		
	<b>Roll</b>	<b>Pitch</b>	<b>Heading</b>
Vehicle to reference alignment angles (deg)	0	0	0
Reference to IMU alignment angles (deg)	-1.875	-2.282	-0.304
	<b>X (Bow +)</b>	<b>Y (+ Stbd)</b>	<b>Z (+ Down)</b>
Reference to IMU lever arm (m)	0.016	-0.006	0.102
Reference to primary GNSS lever arm (m)	0.290	1.646	-6.015

### 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/ETRS89 Ellipsoid and LAT.

Figure 4 provides a basic illustration of the reduction of soundings data using the UKHO VORF model value for LAT.





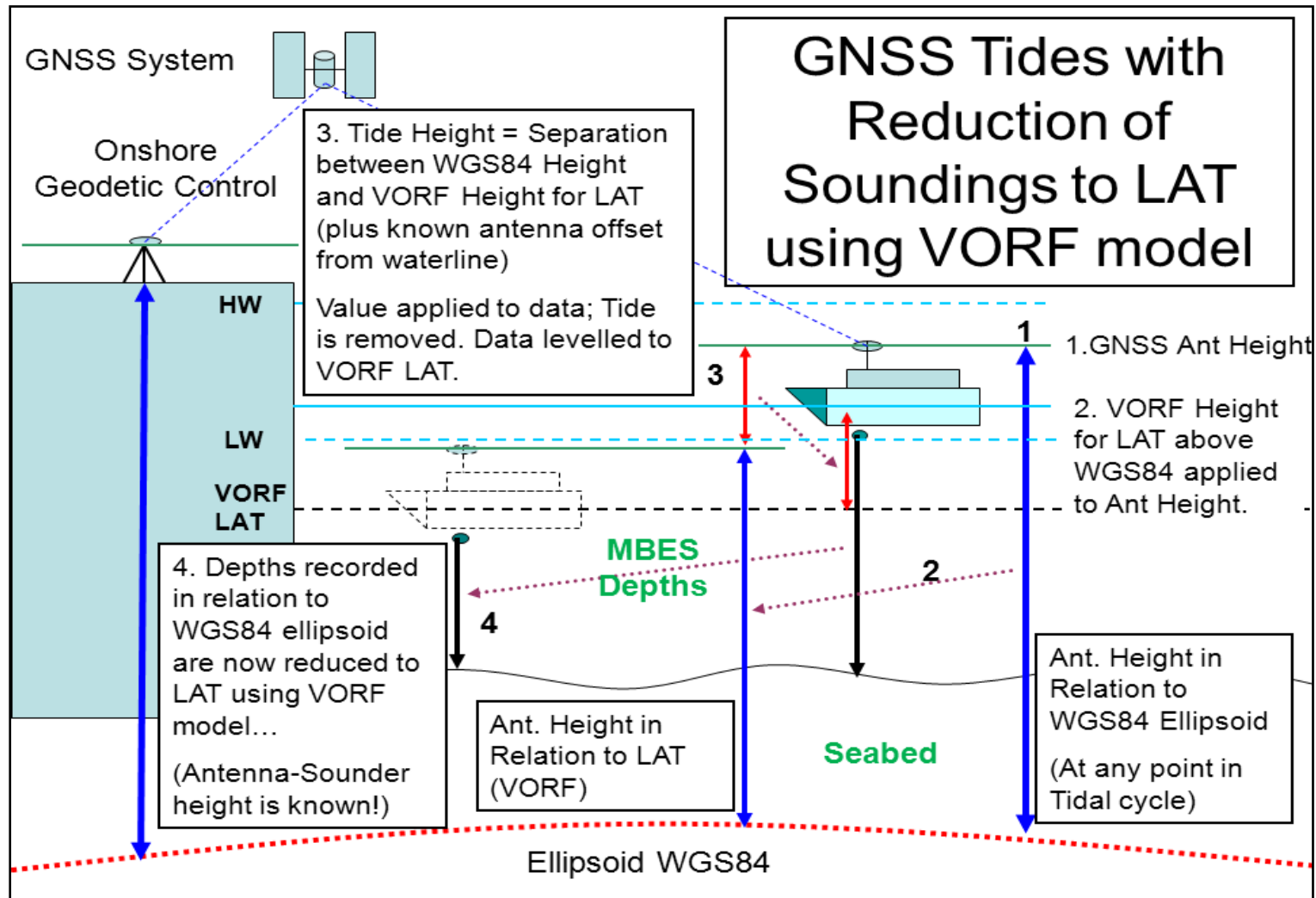


Figure 4: VORF-GNSS Reduction of Soundings

## 4. Survey Data Summary (Data Rendered)

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### 4.1. Overview

Survey data acquisition conducted by GSI in the surveying of North Wales in 2020 for CHERISH 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 vessel.

### 4.2. MBES Data

Table 11: MBES Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY 20_03
MBES System	Kongsberg Simrad EM2040D
Survey Lines (including crosslines)	387
Data Files	403 (including test lines)
Date Created	01/09/2020 – 19/09/2020
Dataset size	232 GB
File format	.ALL

### 4.3. SBES Data

Table 12: SBES Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY 20_03
SBES	Simrad EA400
Survey Mainlines	0
Data Files	0
Date Created	N/A
Dataset size	0 MB
File format	.asvp, .dg, .out, .raw, .txt, ..xyz

### 4.4. Shallow Seismic Data

Table 13: Shallow Seismic Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg & Year	KRY 20_03
Chirp	Edgetec 3200XS
Survey Mainlines	382
Data Files	396
Date Created	03/09/2020 – 18/09/2020



Dataset size	8.75 GB
File format	.JSF

#### 4.5. Navigation Data

Table 14: Navigation Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY 20_03
Navigation System	POS-MV
Data Files	151 (excluding USB backup)
Date Created	01/09/2020 – 18/09/2020
Dataset size	8.81 GB
File format	.000/.001 etc. POS MV format

#### 4.6. Water Column, Sound Velocity and Oceanographic Data

Table 15: Sound Velocity Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY 20_03
Instrument	Valeport SWiFT SVP (Bluetooth)
Sound Velocity Data Files	14 CARIS Daily Files (each day's casts combined into one file)
Dataset size	206 KB (CARIS format)
Date Created	01/09/2020 – 18/09/2020
File formats	CARIS .svp

#### 4.7. Backscatter Data

Table 16: Backscatter Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary
Survey Leg	KRY 20_03
MBES System	Kongsberg Simrad EM2040D
Backscatter	ARA, GeoTIFFS, Lines, Statistics
Survey Lines	382
Data Files	421
Dataset size	984 MB
File format	.asc, .tiff, .txt,

#### 4.8. QINSy Online Navigation Data

Table 17: QINSy Project Data logged during CHERISH Wales Marine Survey 2020

Descriptor	Metadata
Vessel	R.V. Keary



Survey leg	KRY 20_03
Dataset size	260 GB
Data Files	1400

#### 4.9. Final Data Delivery

The table below details the total amount of data generated by R.V. Keary during CHERISH Wales Marine Survey 2020.

**Table 18: Final Data Delivery from CHERISH Wales Marine Survey 2020**

<b>Survey Leg</b>	<b>Dataset Size</b>
<b>KRY20_03</b>	<b>1.30 TB, 28,036 files</b>



# 5. Data Processing

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## 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 2.3 of this document, in order to ensure the required standards were obtained.

Finalisation of all MBES datasets (1 survey leg) which encompasses the overall 2020 CHERISH North 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 (via Qimera) and imported into CARIS HIPS & SIPS software. Once converted, survey datasets were then organised by Julian day. The following workflow was followed:

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:

- Reprocessed navigation data from POS-PAC was applied to survey data.
- 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.
- Errors due to residual refraction effects or residual tide are resolved or corrected using the tools available in Qimera.
- Data is assessed for any remaining systemic issues and addressed as appropriate.
- Data is then exported to the GSF format

The GSF files are then loaded to a Caris HIPS & SIPS project structure.



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.

During manual cleaning, data from the shallow areas in Sarn Badrig and Dinas Dinlle were observed to have a high degree of noise. It is not known if this poor signal-to-noise ratio resulted from:

- a) Short distances from transducer faces to seafloor and related signal response.
- b) Acoustic contamination due to reverberation of vessel engine noise in shallow water.
- c) Mobilisation of sediment due to vessel progress.
- d) Boulders occurring on seabed
- e) Marine vegetation

When operating in Irish waters, the RV Keary would ordinarily work in conjunction with smaller vessels which would survey very shallow areas. Due to the location of the survey area and restrictions imposed by COVID19, it was not possible to partner a smaller vessel with the RV Keary in this instance. As such, the RV Keary surveyed all depths – even those that may have been better addressed by a smaller vessel.

While the source of the poor signal-to-noise cannot be fully resolved, it should be noted that the 0.1 m grid of the seabed around the Bronze Bell wreck on Sarn Badrig indicates a high density of boulders, likely the result of winnowing of a sub-glacial till. This suggests that in places the “noise” is a result of an uneven seabed. Therefore, in all instances, a ‘best effort’ was employed to remove false returns while preserving true seafloor response; despite a sub-optimal signal to noise ratio.

### **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

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### 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 10 minutes prior to departure, then continuously throughout the day and for 10 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 10 minutes before resuming survey operations).
6. 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 7.
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 QPS Qimera & 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 6.7 of this document) was carried out on the dataset to demonstrate that the final product met all required specifications.

## 6.4. Survey Standard

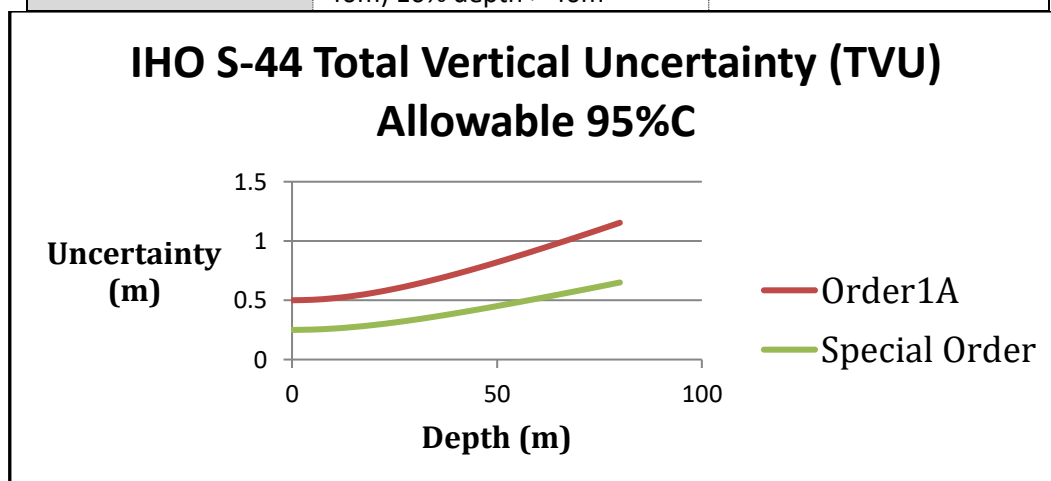
The survey reported here was carried out to International Hydrographic Organization (IHO) Order 1a standard as per special publication S-44.

Table 19 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.

**Table 19: IHO Standards for Hydrographic Surveys**

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



**Figure 5: 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.

**Table 20: 2020 Standard Deviation values used in TPU calculation**

<b>Propagator</b>	<b>Standard Deviation</b>
Heave Error	2% of Heave Amplitude
Measurement Errors	0.005 m
Gyro Alignment Errors	0.05 deg
Pitch Alignment Errors	0.01 deg
Roll Alignment Errors	0.01 deg
Gyro Measurement Error	0.02 deg
Pitch Measurement Error	0.01 deg
Roll Measurement Error	0.01 deg
Navigation Measurement Error	0.03 m
Transducer Timing Error	0.002 s
Navigation Timing Error	0.002 s
Gyro Timing Error	0.002 s
Heave Timing Error	0.002 s
Pitch Timing Std Dev	0.002 s
Roll Timing Error	0.002 s
Sound Velocity Measurement Error	2 m/s
Surface Sound Velocity Measurement Error	0.1 m/s
Tide Measurement Error	0.08 m

## 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 Wales Marine Survey 2020 in the Sarn Badrig survey area. 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 the CHERISH Wales Marine Survey 2020 dataset (Table 21). Vessel track-lines are illustrated in Results Section 8.1. This imagery illustrates the location of the cross-lines used for QC

**Table 21: KRY20\_03 Cross-line Statistics**

Beam Angle (deg)	Count	Max (+)	Min (-)	Mean	Std Dev	Special Order (%)	Order 1a (%)
-70.0 - -60.0	3,088,497	0.465	0.783	-0.017	0.059	99.791	99.992
-60.0 - -50.0	1,648,011	0.961	0.913	-0.011	0.061	99.657	99.986
-50.0 - -40.0	1,069,458	0.804	0.840	-0.006	0.061	99.717	99.985
-40.0 - -30.0	793,455	0.684	0.835	-0.005	0.064	99.667	99.964
-30.0 - -20.0	647,439	0.706	0.766	-0.005	0.065	99.716	99.979
-20.0 - -10.0	570,232	0.464	0.743	-0.008	0.065	99.737	99.993
-10.0 - 0.0	944,366	0.756	0.921	-0.012	0.066	99.674	99.978
0.0 - 10.0	961,176	0.706	1.072	-0.013	0.066	99.617	99.968
10.0 - 20.0	583,853	2.086	0.599	-0.012	0.066	99.656	99.990
20.0 - 30.0	664,262	0.600	0.564	-0.009	0.065	99.727	99.988
30.0 - 40.0	810,769	0.616	0.882	-0.011	0.062	99.794	99.985
40.0 - 50.0	1,091,733	0.751	0.879	-0.015	0.062	99.741	99.988
50.0 - 60.0	1,676,576	0.659	0.647	-0.019	0.060	99.738	99.989
60.0 - 70.0	3,157,246	0.656	0.765	-0.024	0.060	99.733	99.995

## 6.8. System Checks and Calibration

### 6.8.1. Calibration Patch Tests

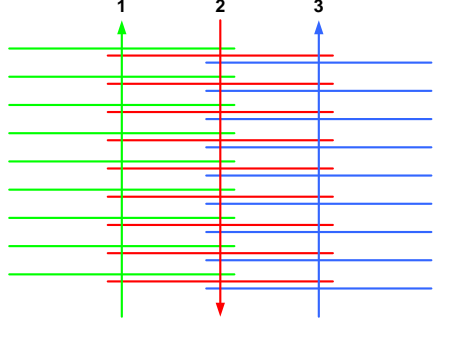
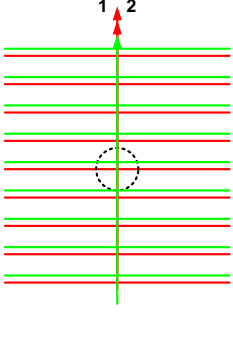
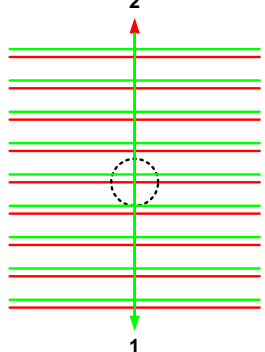
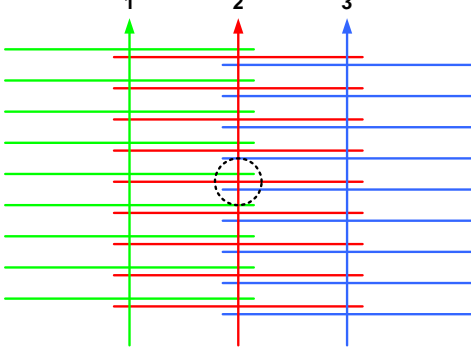
A full set of tests and checks were carried out for each vessel at the outset of 2020 INFOMAR survey operations. The accuracies of these outcomes were validated periodically through standard patch tests and QA'd by the on board data processors as survey operations were being undertaken.

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 2020 survey leg are provided in the individual survey leg reports which are available on request from INFOMAR project management.



Table 22: Standard Patch Test Calibration Run Lines

Roll Calibration	Timing Calibration
	
Pitch Calibration	Heading Calibration
	

## 6.9. Sounding Density

Sounding densities for CHERISH Wales Marine Survey 2020 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 2m<sup>2</sup> 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.

Excluding cells at the extreme periphery of the data, there was complete coverage of >9 "hits" per 2m<sup>2</sup> grid.



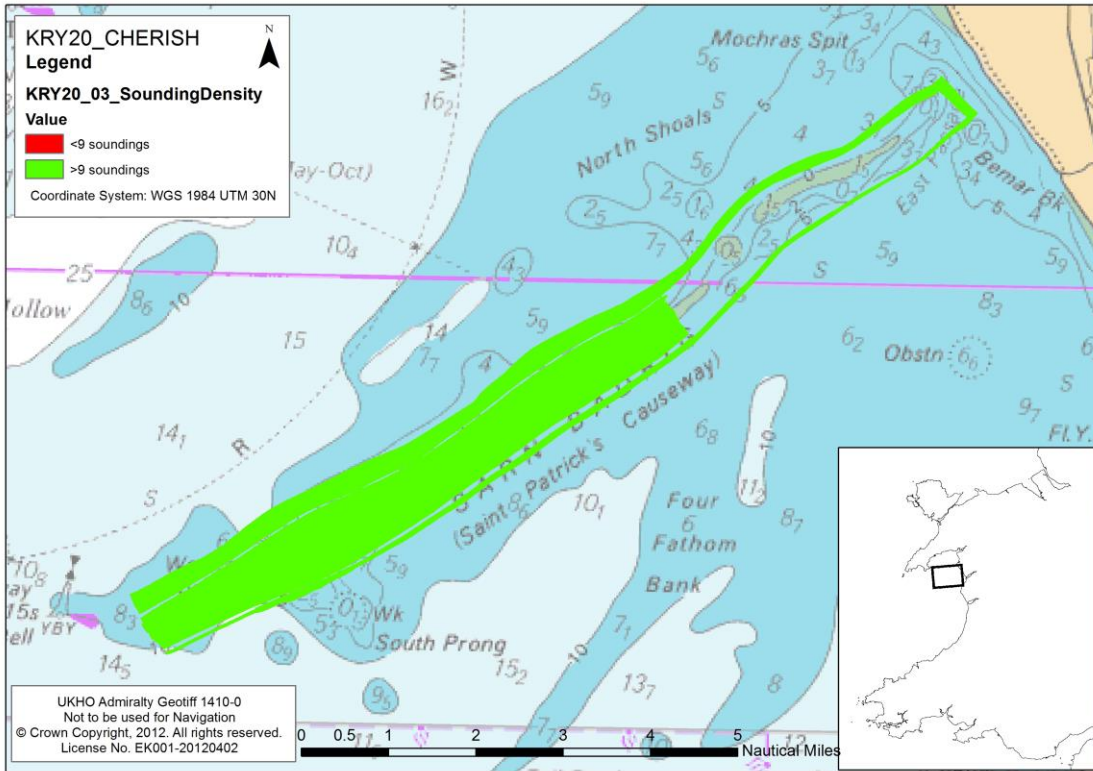


Figure 6: KRY20\_03 Sounding Density from Sarn Badrig region: 2m<sup>2</sup> Base Surface

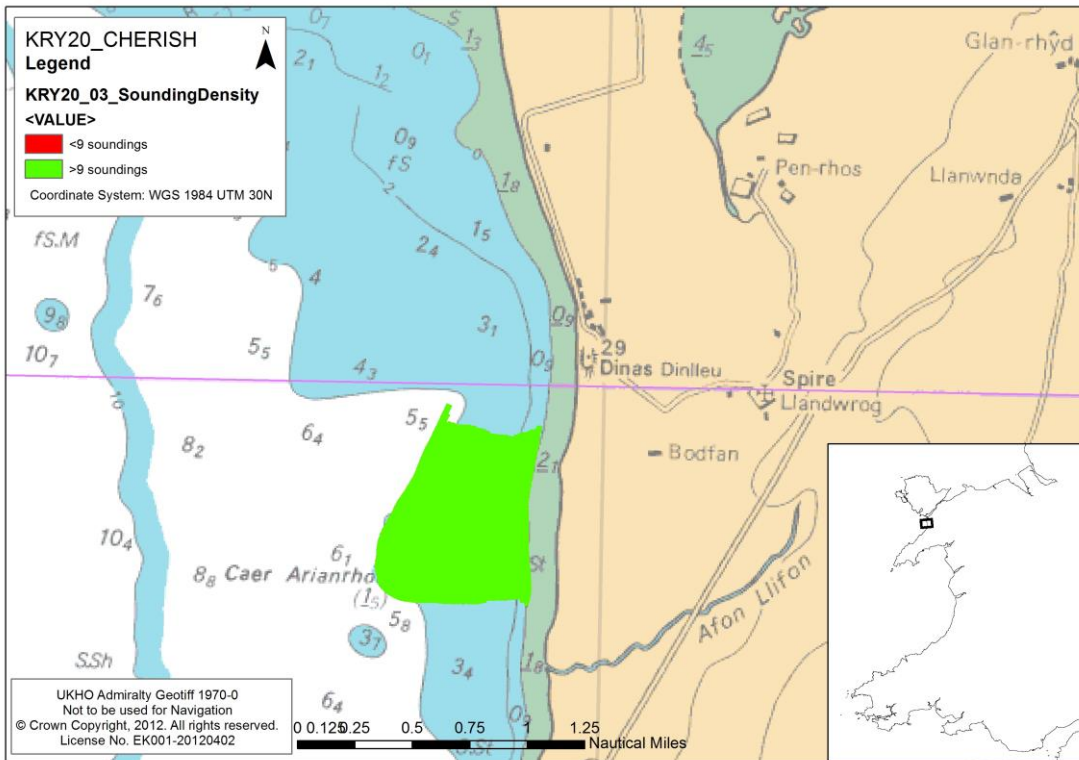


Figure 7: KRY20\_03 Sounding Density from Dinas Dinlle region: 2m<sup>2</sup> Base Surface

## 6.10. Ground truthing

Ground truthing was not carried out as part of the CHERISH Wales Marine Survey 2020.



# 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.

**Table 23: Survey Data Directory Structure**

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	

## 7.2. Data Deliverables

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

**Table 24: Survey Deliverables**

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 Earth files.	Geo-referenced TIFF images 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

To get a copy of data associated with the survey, please request it from the CHERISH project by contacting [info@cherishproject.eu](mailto: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 two locations around North Wales from 01/09/2020 to 19/09/2020. The two locations are described for the purposes of this report as: Sarn Badrig and Dinas Dinlle.

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.

### 8.1.1. Sarn Badrig

23.9 km<sup>2</sup> was surveyed across 260 survey lines covering 825.3 km in the Sarn Badrig region (Figure 8). Depths ranged from -14.74 to -0.12 m (LAT), with a mean depth of  $-7.35 \pm 2.84$  m (s.d.) (Figure 9). In 2019, the length of the reef was surveyed as reconnaissance, with the shallow part surveyed to provide context for the wreck of “The Diamond”. In 2020, the focus was on the outer and deeper parts of the reef.

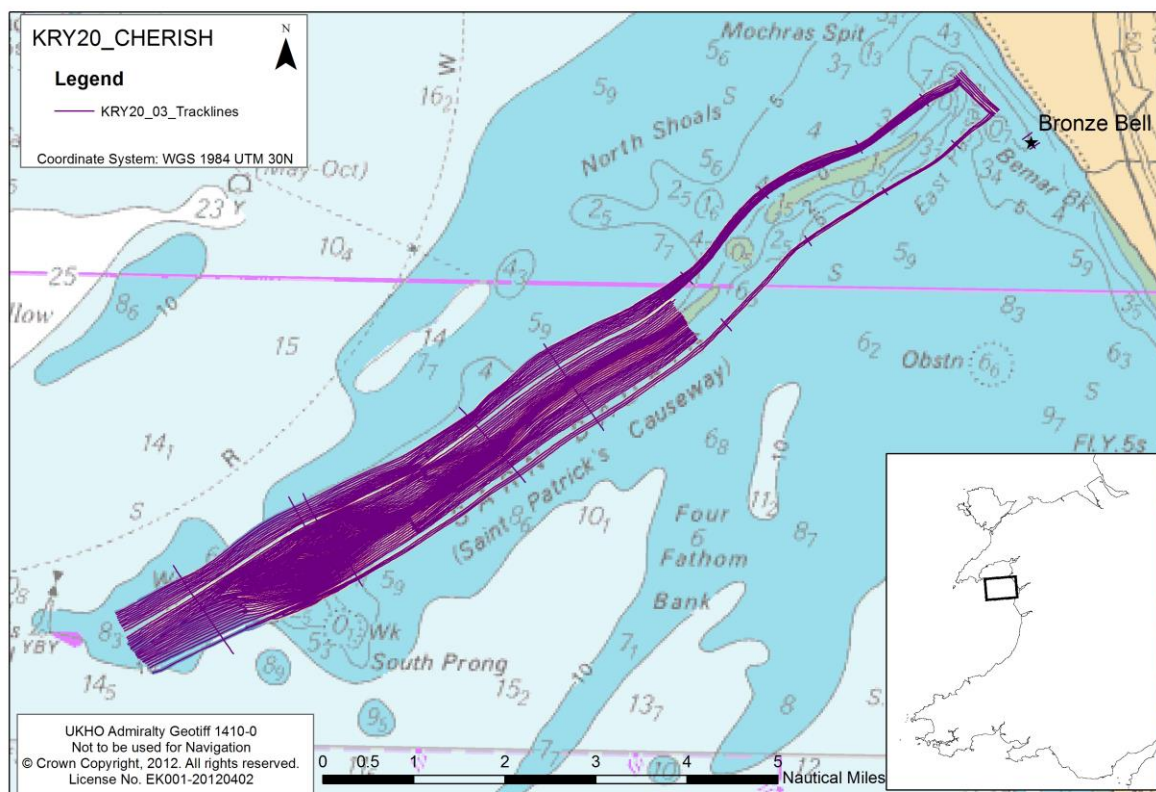


Figure 8: Vessel tracklines for Sarn Badrig, including crosslines, surveyed in 2020



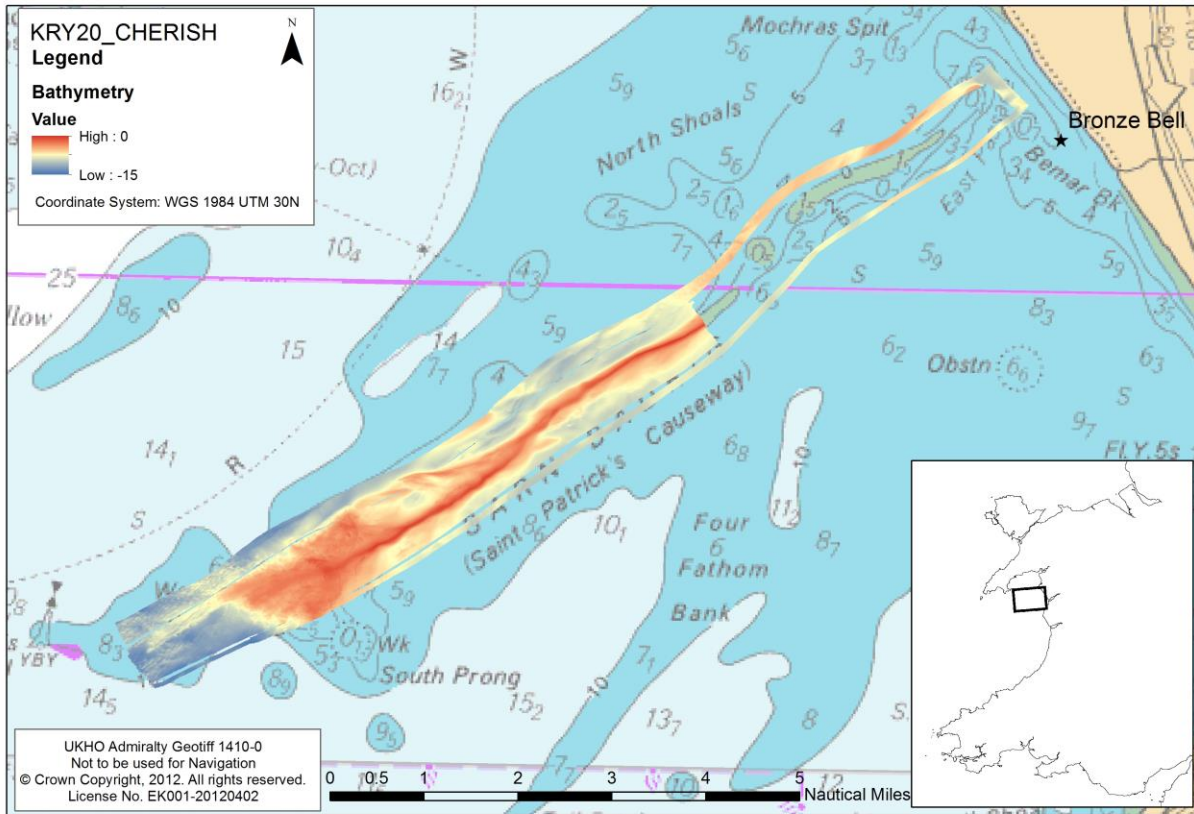
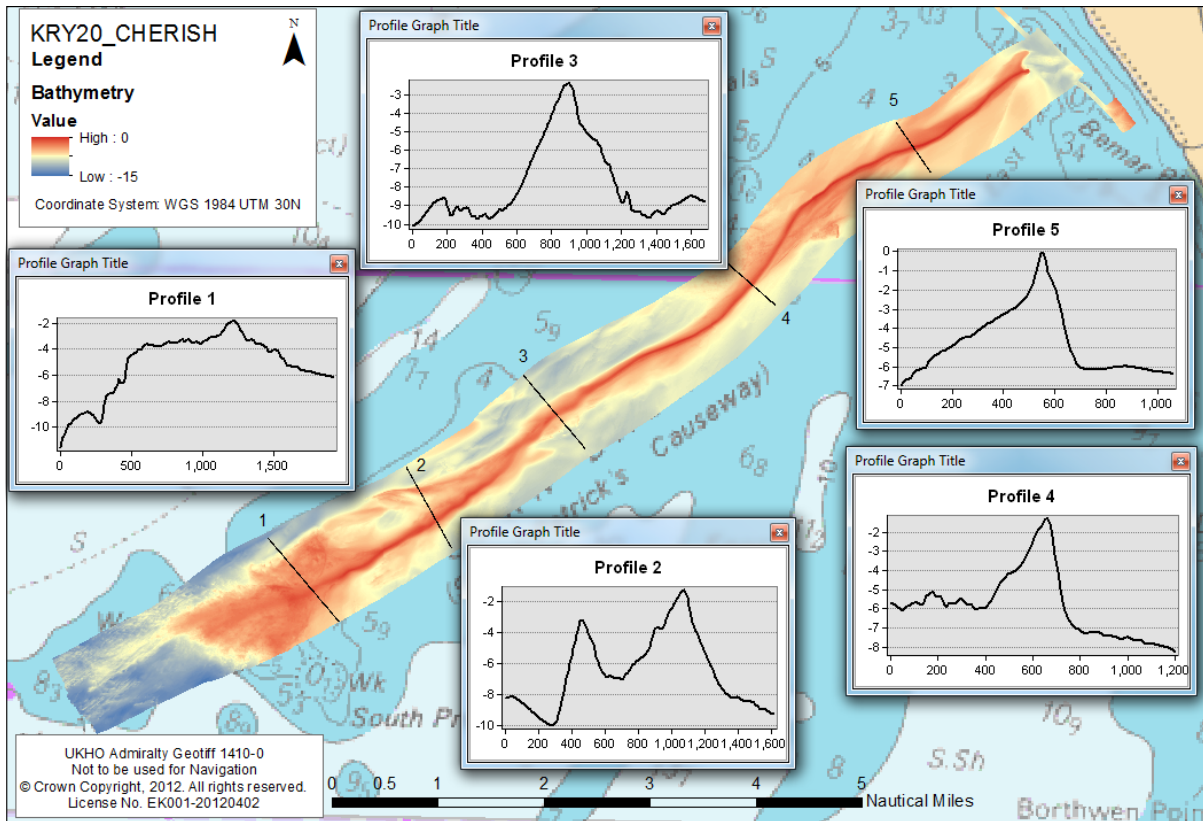


Figure 9: Bathymetry for the Sarn Badrig region acquired in 2020

Combining 2020 and 2019 survey results indicate a narrow (~80 m), 16 km long sinuous ridge along the apex of the reef (Figure 10). This is up to 8 m higher than surrounding seafloor and the ridge is situated at depths of 0 – 2 m. The north of the reef is shallower (~6 m) than the south (~11 m). The southern end of the ridge ends in a broad elevated triangular shaped platform (1.5 km wide, 2.5 km long). The sinuous morphology of the ridge, terminating in deeper waters in the broad platform is similar to that of an esker and delta system. Eskers form under the grounded base of an ice mass.







**Figure 10: Combined 2019 and 2020 CHERISH bathymetry data from Sarn Badrig showing sinuous ridge along apex of reef, terminating in a triangular elevated platform similar to an esker-delta landform assemblage. Profiles at five locations along ridge (axes in m, northwest to southeast).**

### 8.1.2. Dinas Dinlle

The objective of the survey was to extend data acquired in 2019 offshore of the CHERISH study site Dinas Dinlle promontory fort to the south to include the reef of Caer Arianrhod. 1.7 km<sup>2</sup> was surveyed across 78 survey lines covering 74.1 km off Dinas Dinlle. Depths ranged from -7.47 to 0.60 m (LAT), with a mean depth of  $-3.03 \pm 1.34$  m (s.d.). The bathymetry was extended onshore as much as possible to facilitate a seamless onshore-offshore map to be created.



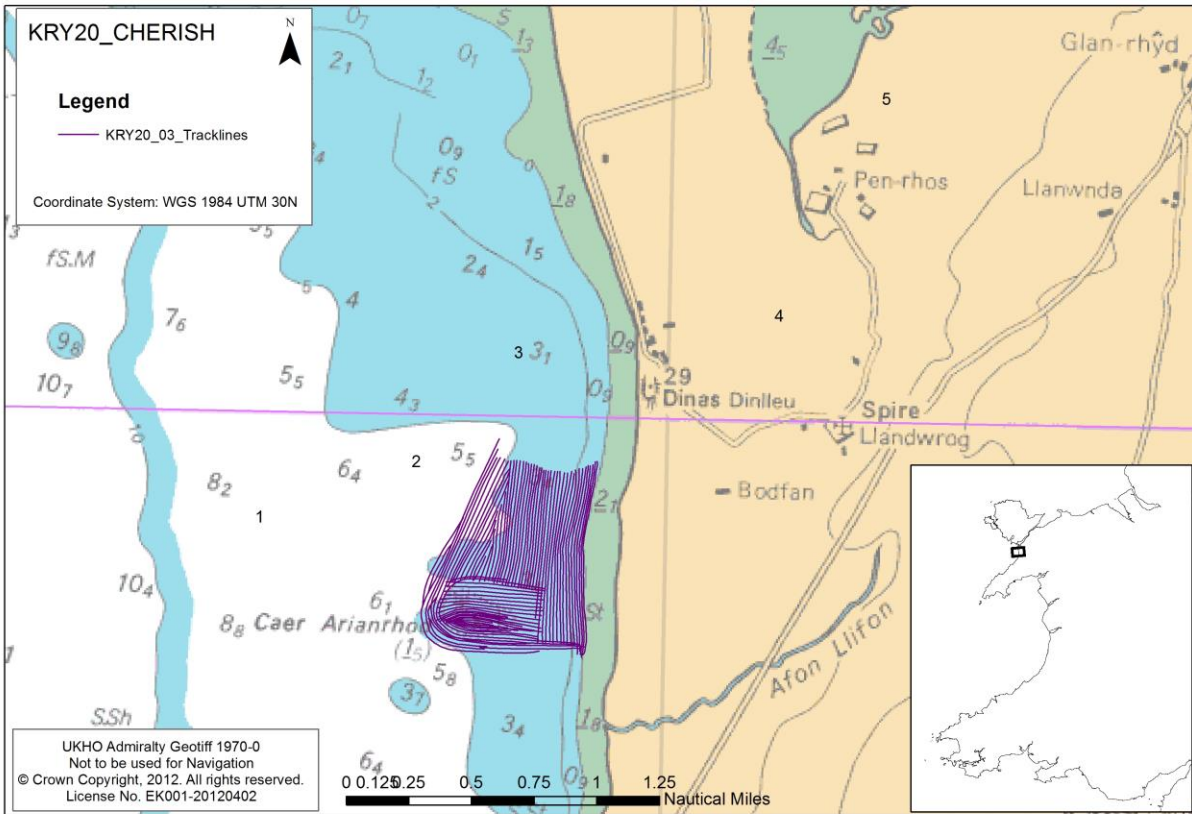


Figure 11: Vessel tracklines for Dinas Dinlle, including crosslines, surveyed in 2020

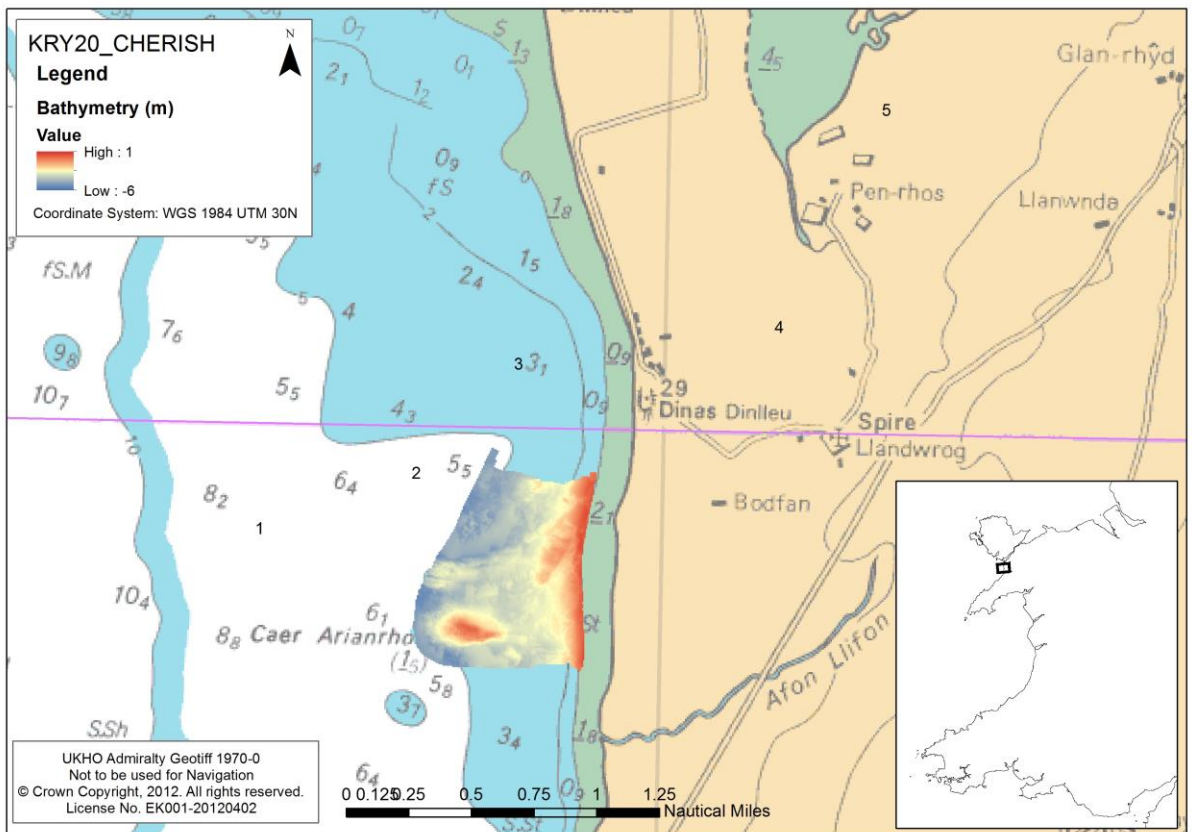


Figure 12: Bathymetry for the Dinas Dinlle region acquired in 2020, including the Caer Arianrhod reef



Bathymetry data acquired in 2020 includes the tear-drop shaped Caer Arianrhod.

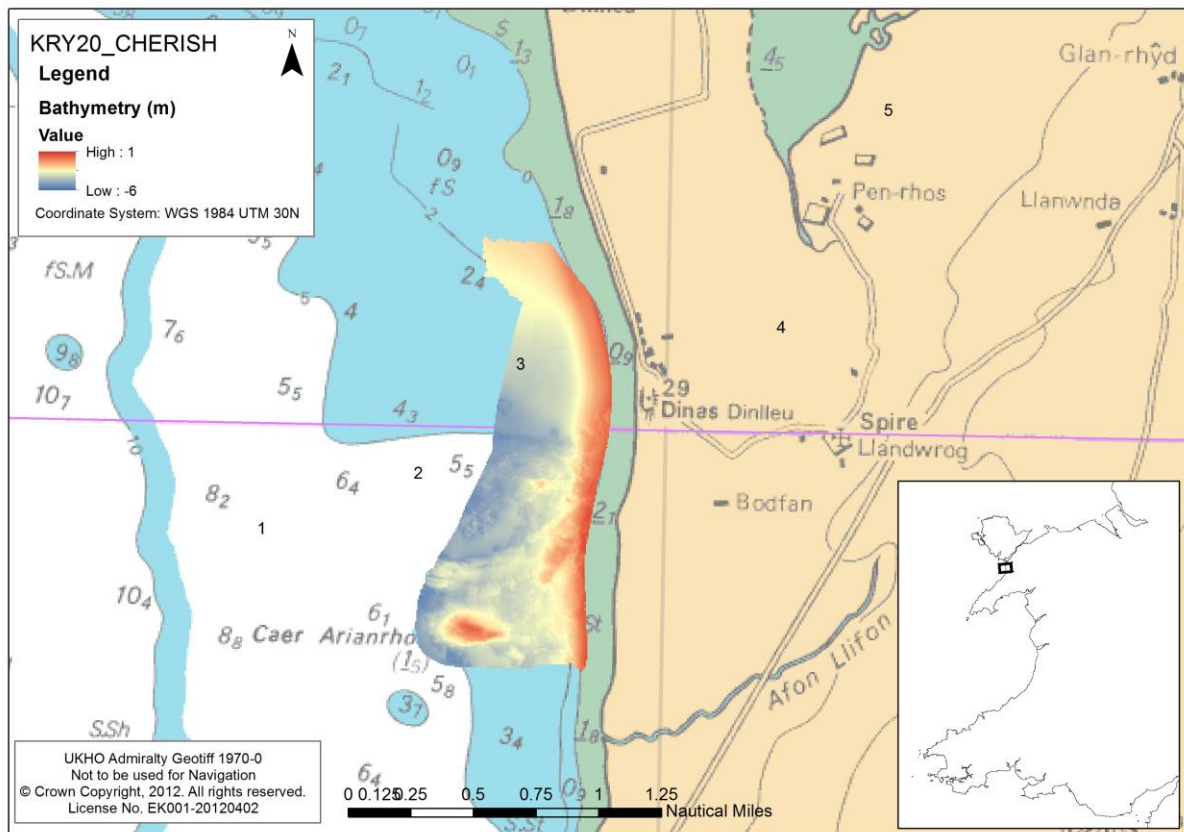


Figure 13: Combined 2019 and 2020 CHERISH bathymetry data from Dinas Dinlle, with Caer Arianrhod reef in south of survey area.

## 8.2. Backscatter Data

Backscatter from KRY20\_03 has been compiled into the backscatter mosaics shown in the figures below. Harder substrate (e.g. bedrock or gravel) returns a higher backscatter signal than softer substrate (e.g. muds). All locations show a diverse seabed type with both hard and soft substrates present.

In Dinas Dinlle, soft sediment is found in the north of the survey area, with harder substrate forming Caer Arianrhod and surrounding seabed area (Figure 14 and Figure 15).



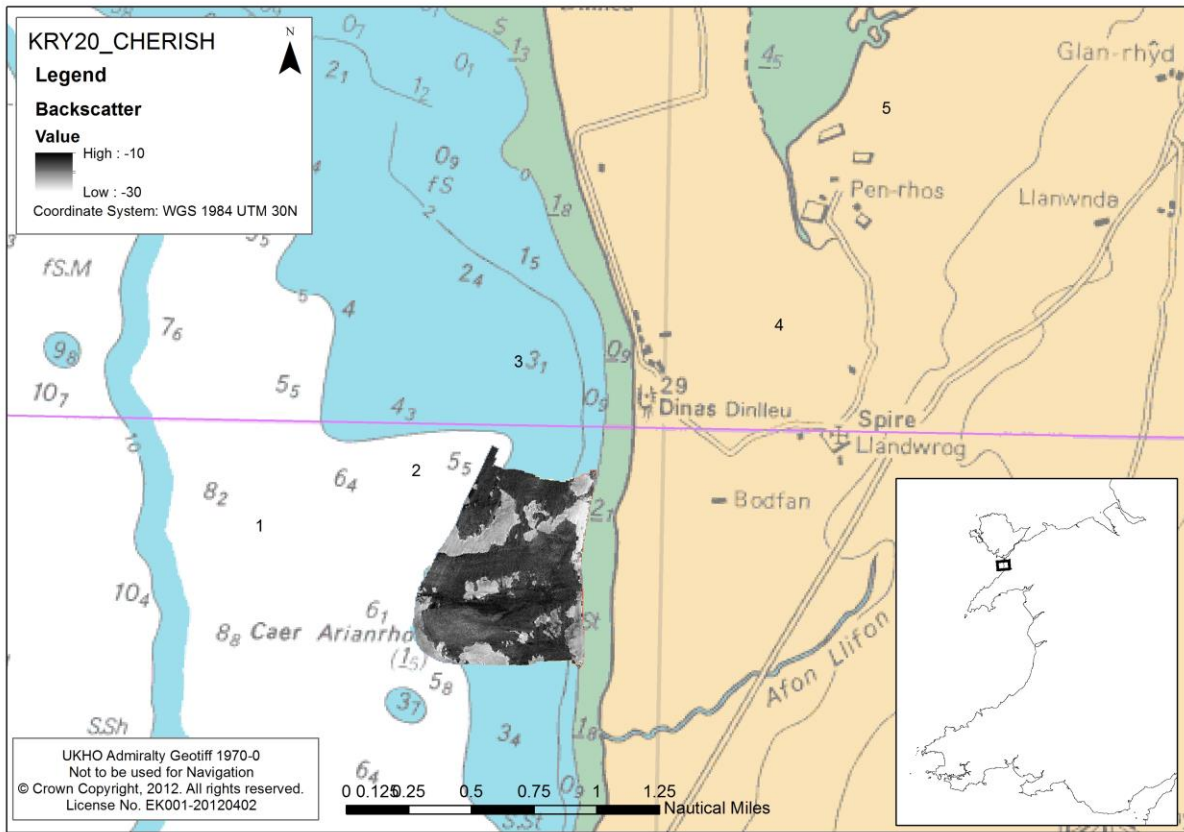


Figure 14: Backscatter coverage (2m grid) for Dinas Dinlle acquired in 2020

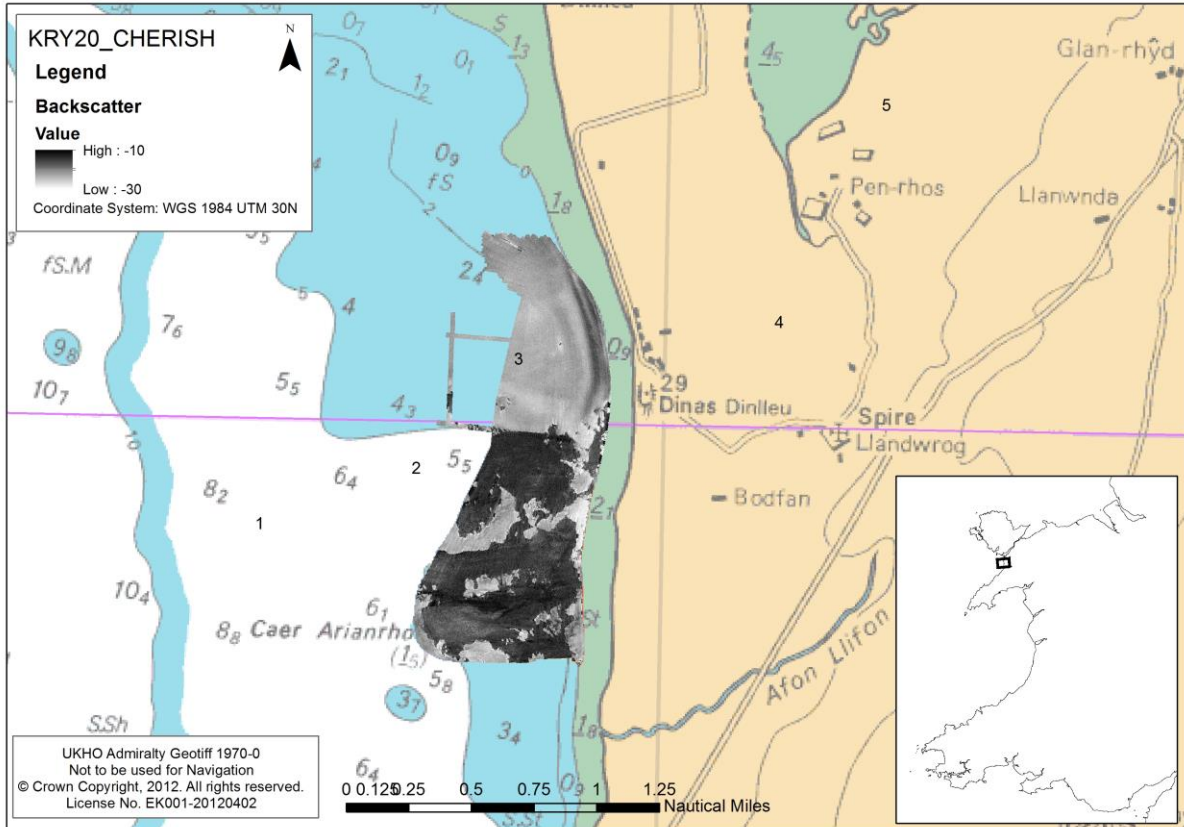
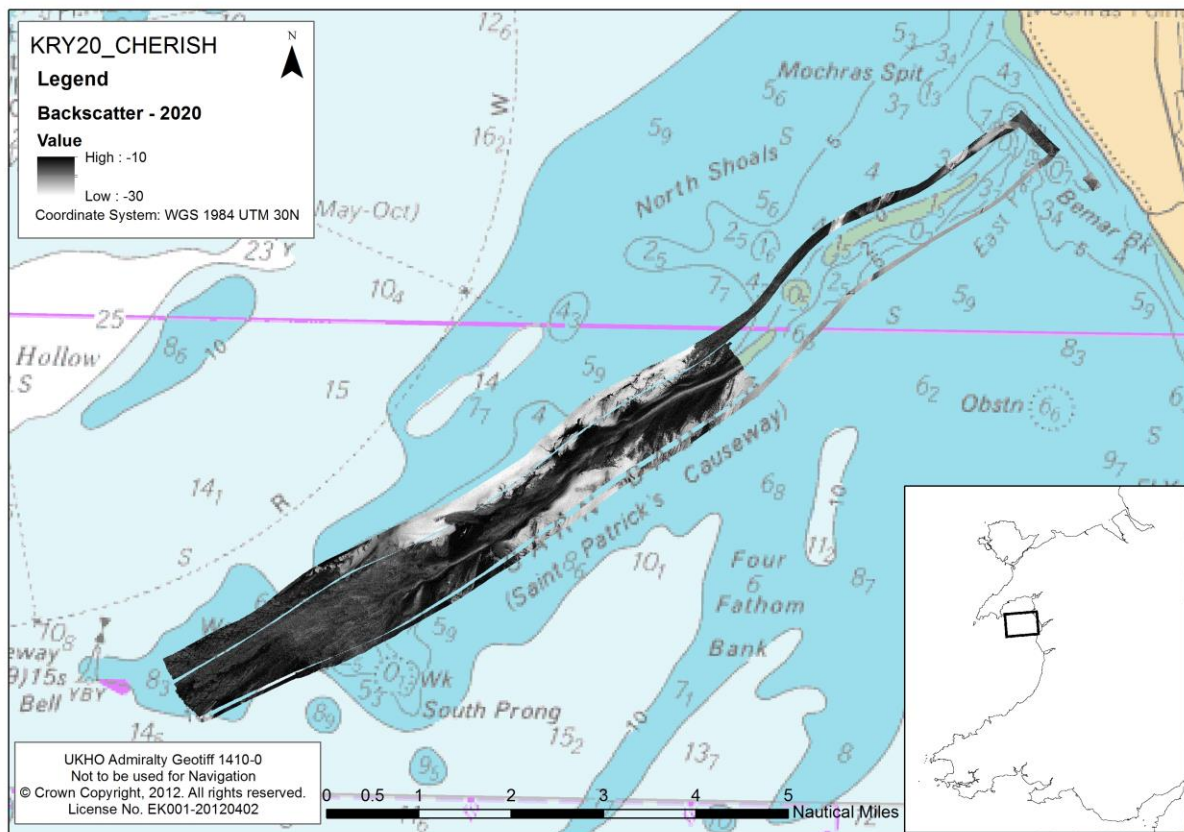


Figure 15: Combined backscatter coverage (2m grid) for Dinas Dinlle acquired in 2019 and 2020



In Sarn Badrig, harder substrate makes up the elevated platforms, with softer substrate at lower depths on the flanks of the reef, and along the crest of the sinuous ridge (Figure 16 and Figure 17).



**Figure 16: Backscatter coverage (2m grid) for Sarn Badrig acquired in 2020**



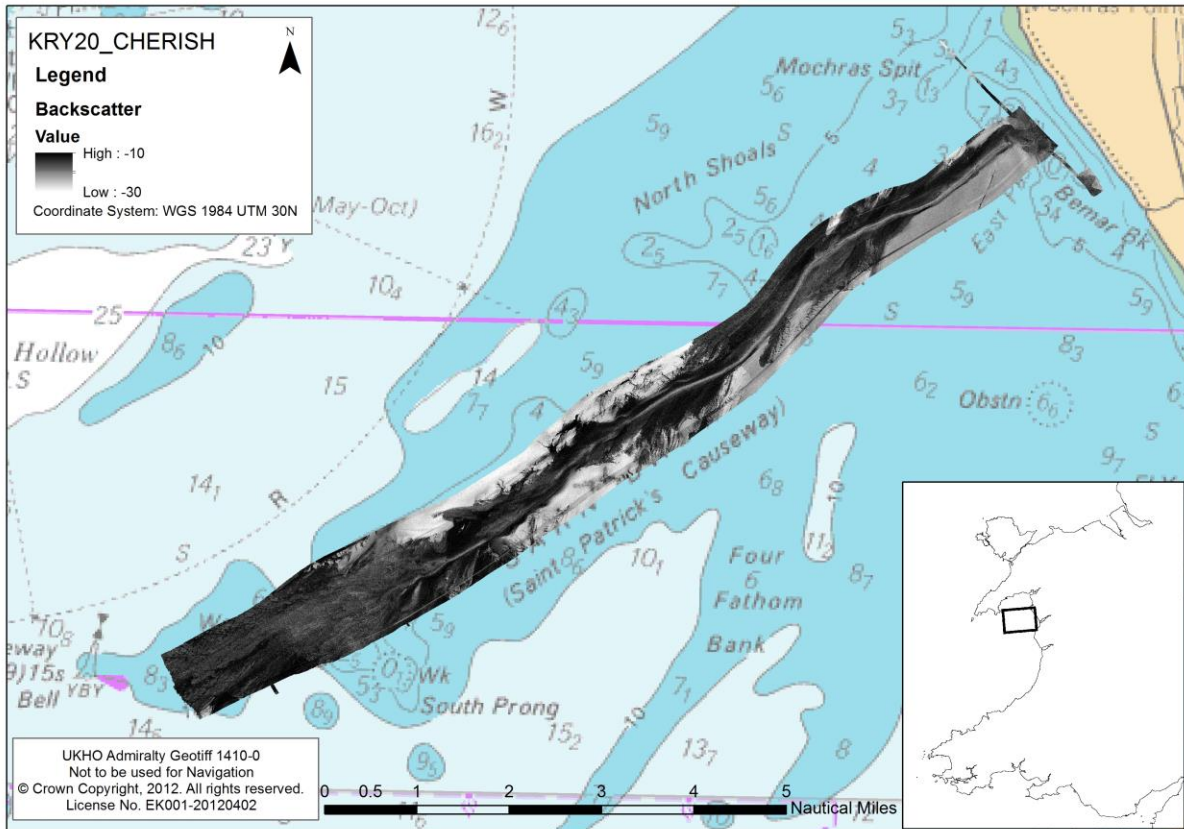


Figure 17: Combined backscatter coverage (2m grid) for Sarn Badrig acquired in 2019 and 2020

### 8.3. Shallow Seismic Data

Shallow seismic data was acquired by the R.V. Keary during the CHERISH North Wales 2020 survey.

Details of the dataset acquired are provided in Section 4.4 and the locations of the various ship track-lines may be viewed in Section 8.1 of this document. Water depths were very shallow during data acquisition.

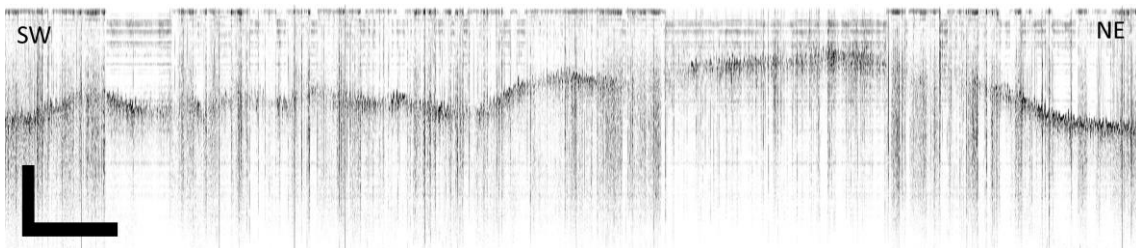


Figure 18: Example of shallow seismic data from Line 0106. Vertical scale bar 5m, horizontal scale bar 500m

### 8.4. Wreck Surveys

Two shipwrecks were surveyed (Table 25). The remains of the “Bronze Bell” and surrounding debris field were recorded, along with an unnamed wreck discovered during the multibeam survey of Sarn Badrig. Wreck surveys were gridded at 0.1 m resolution.

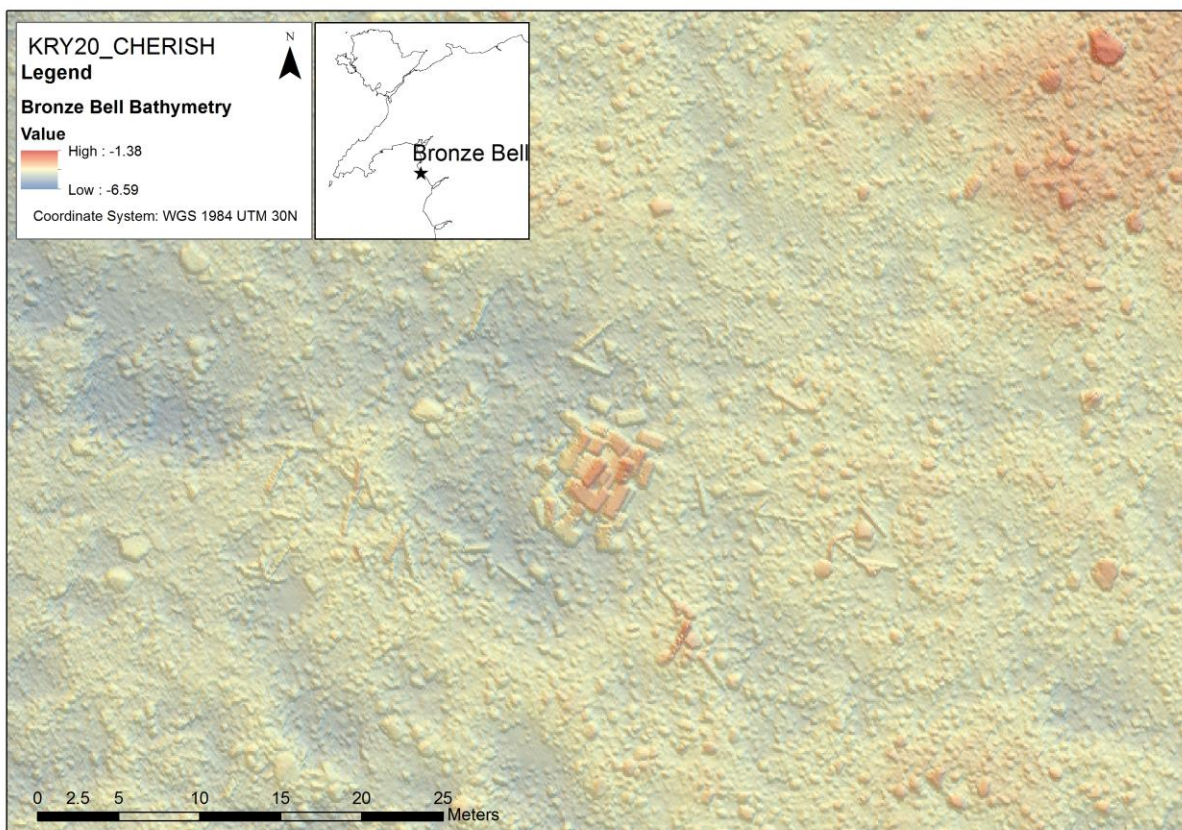


During cleaning of the data two further wrecks were identified. Three H525 forms were completed and are contained in Appendix C.

**Table 25: Wrecks surveyed in North Wales**

Wreck	Northing	Easting	Result
Bronze Bell	52.78694°	-4.131389°	Full multibeam survey completed
Unnamed Wreck	52.77489	-4.18856	Full multibeam survey completed

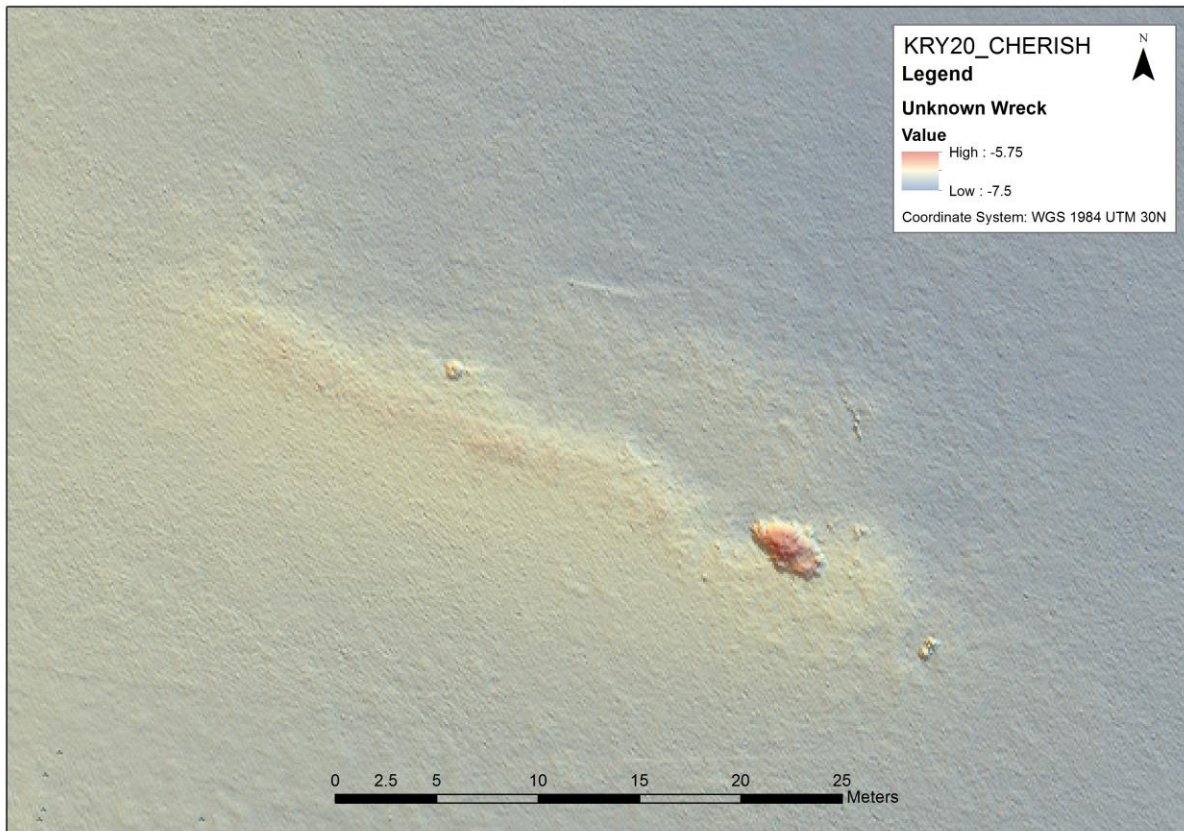
The Bronze Bell was surveyed in 10<sup>th</sup> September 2020. The debris field of the wreck including Carrara Marble, anchors and cannon was surveyed (Figure 19). The seabed in the vicinity is rough, with large boulders present.



**Figure 19: Debris field of the Bronze Bell (0.1m resolution). See Figure 1 for location**

An unnamed wreck was located during the bathymetry survey on 4<sup>th</sup> September 2020 and surveyed on 10<sup>th</sup> September 2020. The length was measured at 41 m, with a width of 15 m. The main structure of the wreck appears to be well collapsed and / or buried. The bow is most likely oriented pointing WNW, with the highest point of the wreck being at the stern section approx. 1m from the seabed. There appears to be debris on the east side of the wreck site approx. 10-15m from the 'centre line'. There are reports of the wreck 'Diamond' sunk in general area. Dimensions correlate with Wreck Site EU information on SV Diamond {built 1823, length 39.6m}





**Figure 20: Unnamed wreck on Sarn Badrig (0.1m resolution).**

## 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)

Two H102 forms were submitted to the UKHO arising from the CHERISH North Wales 2020 survey. These are detailed in Appendix C with a total of 3 observations made.

H102-KRY20\_03-001

- Adjustment of 2m contour
- Adjustment of sounding, chart indicates 3.4m; least depth of 1.32m observe

H102-KRY20\_03-002

- Adjustments to 5m contour in two locations

## 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 Appendix B MMO Report CHERISH Wales Marine Survey 2020.

No marine mammals were observed during survey operations.





## **8.8. Seabed Sampling and Ground-truthing**

Seabed sampling was not carried out as part of the CHERISH Wales Marine Survey 2020.



# 9. Conclusion

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## 9.1. Conclusions and Final Remarks

All survey work was carried out to IHO S-44 Order 1a Standard. Bathymetry datasets from 2020 CHERISH North 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.

Bathymetry data acquired at both Dinas Dinlle and Sarn Badrig as part of the CHERISH project in 2019 was extended in this 2020 survey. At Dinas Dinlle, the Caer Arianrhod reef was surveyed and will be included in a seamless onshore – offshore map of the area combined with CHERISH UAV intertidal elevation data. At Sarn Badrig, a possible esker located along the axis of the reef terminating to the southwest in an offshore delta was surveyed.

Increased cleaning of depth soundings was required in Dinas Dinlle and Sarn Badrig to produce a coherent seabed. A lot of noise was present, with many soundings above and below seabed. At Sarn Badrig, the detailed wreck surveys (at 0.1m resolution) reveal the seabed to be composed of large boulders, with dimension of <2m. These boulders would lead to the appearance of “noise” when gridded at 2m. Best efforts were made to contain these boulder soundings in the final data delivery. It is possible the shallow nature of Dinas Dinlle, in combination with strong tides and mixed substrate caused the increased noise observed here.

A CHERISH survey is planned for 2021 (subject to licence). This survey will focus on completing the multibeam data acquisition area around Sarn Badrig, focussing on the interpreted delta. The 2021 survey will also aim to acquire bathymetry from other Welsh areas for seamless onshore-offshore map compilation and collect seabed samples to generate sediment maps for areas surveyed as part of the CHERISH project from 2018.



# References

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IHO Standards for Hydrographic Surveys (S-44) 5<sup>th</sup> 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



# Glossary

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GSI:	Geological Survey Ireland
IHO:	International Hydrographic Organisation
JNCC:	Joint Nature Conservation Committee
UKHO:	United Kingdom Hydrographic Office
DECC:	Department of the Environment, Climate and Communications
STCW95:	Standards of Training Certification and Watch-keeping
MBES:	Multibeam Echosounder
SBES:	Singlebeam Echosounder
SBP:	Sub-bottom Profiler
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



# Appendix A: Diplomatic Clearance for Survey

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# Foreign & Commonwealth Office

Date: 14/08/2020

Ref: 66/2020

The Maritime Policy Unit (Legal Directorate) of the Foreign and Commonwealth Office presents its compliments to the Embassy of Ireland and has the honour to refer to the Embassy's application requesting permission to undertake a marine scientific research cruise in the Territorial Sea/Exclusive Economic Zone of the U

The appropriate United Kingdom authorities have been informed of the proposed marine scientific research cruise KRY20\_CHERISH by the vessel Keary scheduled to take place from 16<sup>th</sup> August – 4<sup>th</sup> October 2020. Approval for the cruise has been given subject to the following conditions being met:

**Please ensure that all raw and processed bathymetric and sub bottom profile data, along with any supporting report, is forwarded to UKHO within 3 months of completion of data collection at [marine.life@ukho.gov.uk](mailto:marine.life@ukho.gov.uk) & [National.Relations@ukho.gov.uk](mailto:National.Relations@ukho.gov.uk)**

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](mailto: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@mca.gov.uk](mailto:row@mca.gov.uk).

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 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.

Due care is taken not to interfere with the activities of commercial fishing vessels when undertaking scientific trials such as this.

If the work 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 KIS-ORCA charts website at [www.kis-orca.eu](http://www.kis-orca.eu) and/or Subsea Cables UK Secretary at [www.subseacablesuk.org.uk](http://www.subseacablesuk.org.uk). If outside UK waters, reference data for these submarine cables and their owners can be found at [www.telegeography.com](http://www.telegeography.com).

If it is necessary to deploy seabed intrusive equipment within one nautical mile of an in service cable, a representative for the work will need to contact the relevant submarine cable owner/operator for prior approval.

We ask that the vessel/master notifies the WFMC on days when the vessel is operational within Welsh waters.

The following information should be emailed in daily to: [WFMCCMPC@gov.wales](mailto:WFMCCMPC@gov.wales)

- Vessel Name
- IMO number
- Vessel Master
- Date
- Location
- Times – on task – off task.

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](mailto:marine.consents@marinemanagement.org.uk) (England and Wales), [marinelicensingteam@doeni.gov.uk](mailto:marinelicensingteam@doeni.gov.uk) (Northern Ireland) or [ms.marinelicensing@scotland.gsi.gov.uk](mailto:ms.marinelicensing@scotland.gsi.gov.uk) (Scotland).

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 are not allowed to 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.

Please have due regard to static fishing gear which can be left unattended, vessels are requested to keep a good navigational lookout and avoid damage to the static gear.

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](mailto: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](mailto: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](mailto:marine.life@ukho.gov.uk) & [National.Relations@ukho.gov.uk](mailto: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](mailto:enquiries@bodc.ac.uk)
- Jane Thompson, RSU Operations, NERC Research Ship Unit, National Oceanographic Centre, Empress Dock, Southampton SO14 3ZH / [yvt@noc.ac.uk](mailto:yvt@noc.ac.uk)
- JNCC Offshore Survey Programme Manager, JNCC, Monkstone House, City Road, Peterborough, PE1 1JY, UK / [offshoresurvey@jncc.gov.uk](mailto:offshoresurvey@jncc.gov.uk). Please provide 2 copies of all publications arising out of the expedition.
- Marine Scotland Access to Sea Fisheries, Marine Laboratory Aberdeen (PO Box 101), 375 Victoria Road, Aberdeen AB11 9DB / [marinescotland@gov.scot](mailto:marinescotland@gov.scot)

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





# Appendix B Marine Mammal Observation Report

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## Document Information

Project title: MMO Report – CHERISH: Wales Marine Survey 2020  
Current Document version Final

Date 12/07/2021

Prepared By	Date	Comment
Kieran Craven	28/06/21	Prepared by Rodinia Consulting Ltd

Reviewed By	Date	Comment

Approved By	Date	Comment
Sean Cullen	12 <sup>th</sup> July 2021	

## Version History

Ver. No.	Ver. Date	Comment	Revised By
1.1	28/06/21		Kieran Craven
Final	12/07/21		Kieran Craven



## Executive Summary

This report details marine mammal observation work conducted on the R.V. Keary during the CHERISH seabed survey of Caernarfon and North Cardigan Bays, North Wales carried out in September 2020. 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 North Wales 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 survey area between the 1<sup>st</sup> and 19<sup>th</sup> September 2020.

No cetacean sightings were made during this time.



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# 1. Survey Vessel / MMO Platform

The CHERISH project utilised one survey vessel, operated by GSI, in the implementation of survey work in CHERISH Wales Marine Survey 2020 - 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. Tables 1 & 2 provide information on her design specifications and survey equipment on board.



**Figure 1: R.V. Keary**



**Table 1: R.V. Keary Vessel Specifications**

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

## 2. Acoustic Equipment

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

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



### 3. Guideline and Licence Implementation

Prior to the commencement of the year's survey operations, a briefing was given to senior 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 survey 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 inshore survey fleet operated by the Geological Survey 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.

CHERISH survey operations in North Wales were implemented on board the R.V. Keary between the 1<sup>st</sup> and 19<sup>th</sup> September 2020. The vessel was based in both Pwllheli Marina and Victoria Dock 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 for this survey 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.





# APPENDIX A: MARINE MAMMAL RECORDING FORM – COVER PAGE

<b>Regulatory reference number</b> (e.g. DECC no., MMS permit no., OCS lease no., etc.) <b>KRY20_03</b>	<b>Country</b>  Wales	<b>Ship/ platform name</b>  <b>R.V. Keary</b>
<b>Client</b> <b>DECC</b>	<b>Contractor</b> <b>CHERISH/GSI</b>	<b>Survey type</b> <input checked="" type="checkbox"/> site <input type="checkbox"/> 4C <input type="checkbox"/> 2D <input type="checkbox"/> VSP <input type="checkbox"/> 3D <input type="checkbox"/> WAZ <input type="checkbox"/> 4D <input type="checkbox"/> other <input type="checkbox"/> <input type="checkbox"/> OBC
<b>Start date</b> <b>01/09/2020</b>	<b>End date</b> <b>19/09/2020</b>	

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

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

<b>Was PAM used?</b>  <input type="checkbox"/> yes <input checked="" type="checkbox"/> no	<b>Number of PAM operators</b>  _____
<b>Description of PAM equipment</b>  _____	



<b>Range of PAM hydrophones from airguns</b> (metres)	<b>Bearing of PAM hydrophones from airguns</b> (relative to direction of travel)	<b>Depth of PAM hydrophones</b> (metres)
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## MARINE MAMMAL RECORDING FORM - OPERATIONS

**Regulatory reference number** KRY20\_03  
(e.g. DECC no., MMS permit no., OCS lease no., etc.)

Caernarfon/Cardigan Bay

**Ship/ platform name:** R.V. Keary

**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)
03/09/2020	L	08:02:00	08:22:00	08:22:00	17:27:00	17:27:00	17:27:00	06:50:00	18:37:00	NA	NA	D	N
04/09/2020	L	09:03:00	09:23:00	09:23:00	17:57:00	17:57:00	17:57:00	06:45:00	19:10:00	NA	NA	D	N
05/09/2020	L	08:36:00	08:56:00	08:56:00	18:09:00	18:09:00	18:09:00	07:15:00	19:20:00	NA	NA	D	N

06/09/2020	L	08:44:00	09:04:00	09:04:00	18:38:00	18:38:00	18:38:00	07:20:00	19:45:00	NA	NA	D	N
08/09/2020	L	09:15:00	09:35:00	09:35:00	18:35:00	18:35:00	18:35:00	08:00:00	20:00:00	NA	NA	D	N
09/09/2020	L	09:45:00	10:05:00	10:05:00	15:45:00	15:45:00	15:45:00	08:45:00	16:54:00	NA	NA	D	N
10/09/2020	L	10:54:00	11:14:00	11:14:00	16:56:00	16:56:00	16:56:00	09:35:00	18:00:00	NA	NA	D	N
12/09/2020	L	08:00:00	08:20:00	08:20:00	17:07:00	17:07:00	17:07:00	06:50:00	18:22:00	NA	NA	D	N
14/09/2020	L	06:33:00	06:53:00	06:53:00	18:40:00	18:40:00	18:40:00	05:20:00	19:54:00	NA	NA	D	N
15/09/2020	L	08:30:00	08:50:00	08:50:00	17:54:00	17:54:00	17:54:00	07:17:00	19:10:00	NA	NA	D	N
16/09/2020	L	09:24:00	09:44:00	09:44:00	11:02:00	11:02:00	11:02:00	06:55:00	11:35:00	NA	NA	D	N
17/09/2020	L	08:03:00	08:23:00	08:23:00	13:02:00	13:02:00	13:02:00	06:55:00	19:17:00	NA	NA	D	N
18/09/2020	L	08:54:00	09:14:00	09:14:00	11:42:00	11:42:00	11:42:00	07:45:00	12:48:00	NA	NA	D	N



## MARINE MAMMAL RECORDING FORM - EFFORT

Regulatory reference number: **KRY20\_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

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

03/09/2020	V	Jess Murray	06:50	18:37	52°53.116' N	4	4°24.465' W	4	6	f	SW	5	3	O	M	W
04/09/2020	V	Jess Murray	06:45	19:10	52°53.116' N	4	4°24.465' W	4	7	f	SW	5	3	O	M	W
05/09/2020	V	Jess Murray	07:15	19:20	52°53.116' N	4	4°24.465' W	4	7	f	W	4	3	O	M	W
06/09/2020	V	Jess Murray	07:20	19:45	52°53.116' N	4	4°24.465' W	4	7	f	W	3	2	O	G	G
08/09/2020	V	Jess Murray	08:00	20:00	52°53.116' N	4	4°24.465' W	4	6	f	SW	5	3	O	P	G
09/09/2020	V	Jess Murray	08:45	16:54	52°53.116' N	4	4°24.465' W	4	5	f	N	3	2	O	G	G
10/09/2020	V	Jess Murray	09:35	18:00	52°53.116' N	4	4°24.465' W	4	6	f	SW	1	1	O	G	G
12/09/2020	V	Jess Murray	06:50	18:22	52°53.116' N	4	4°24.465' W	4	7	f	SW	5	3	O	G	G

14/09/2020	V	Jess Murray	05:20	19:54	52°53.116' N	4	4°24.465' W	4	7	f	NE	1	1	O	G	G
15/09/2020	V	Jess Murray	07:17	19:10	52°53.116' N	4	4°24.465' W	4	7	f	S	1	1	O	G	G
16/09/2020	V	Jess Murray	06:55	11:35	53°08.601' N	4	4°16.650' W	4	5	f	N	2	1	O	G	G
17/09/2020	V	Jess Murray	06:55	19:17	53°08.601' N	4	4°16.650' W	4	5	f	N	2	1	O	G	G
18/09/2020	V	Jess Murray	07:45	12:48	53°08.601' N	4	4°16.650' W	4	6	f	N	2	1	O	G	G



## Cetacean Sighting Record Form: KRY20\_03

No cetaceans were sighted during the survey operations

<b>Date:</b>	<b>Time (GMT):</b> <b>Duration:</b>	<b>Survey Ref. No.</b> KRY20_03	<b>Sighting no.:</b> N/A
<b>How did this sighting occur?</b> (please tick) While you were keeping a continuous watch for marine mammals Spotted incidentally by you or someone else Other (please specify)			
<b>Ship:</b> RV Keary Geological Survey Ireland, Beggars Bush Haddington Road Dublin <a href="mailto:inshore.infomar@gmail.com">inshore.infomar@gmail.com</a>		<b>Observer:</b>	
<b>Location:</b>  <b>Ship's position</b> (latitude and longitude):			<b>Water depth:</b>
<b>Species:</b>		<b>Certainty of identification:</b>	
<b>Estimated Length:</b>		<b>Number of adults:</b>	
<b>Colour:</b>		<b>Number of juveniles:</b>	
<b>Weather:</b>		<b>Photograph or video taken:</b>  <b>Optics Used:</b> None.	
<b>Sighting Description:</b>		<b>Direction of travel of animals in relation to ship:</b>	
<b>Behaviour:</b>		<b>Travel direction of animals</b> (compass points):	
<b>Activity of ship:</b>	<b>Sonar Systems pinging:</b> (when animals first seen)	<b>Closest distance of animals from sonar head:</b> (Record even if not pinging)	



# Appendix C: H-Notes from Survey

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# HYDROGRAPHIC NOTE

**H.102**  
(V8.0 Oct 2014)

Date	28/06/2021	Ref. Number	KRY20_03— 001DH		
Name of ship or sender	Geological Survey Ireland / R.V. Keary / CHERISH				
IMO number if applicable	-				
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland				
E-mail/Tel/Fax of sender	david.hardy@gsi.ie				
General Locality	West of Dinas Dinlleu, Caernarfon region, Wales				
Subject	2m contour adjustment & sounding adjustment, chart 1970				
Position (see <i>Instruction 2</i> )	Latitude	See below		Longitude	See below
	GPS	POSpac -PPRTX	Datum	WGS 84	Accuracy 0.1m
Admiralty Charts affected	1970 (UKHO Geotiff provided 2019)			Edition	Unknown
Latest Weekly Edition of Notice to Mariners held					
Replacement copy of Chart No (see <i>Instruction 3</i> )	<b>IS NOT</b> required				
ENCs affected	<b>NA</b>				
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:  1) Adjustment of 2m contour, centred on 53.070957N 4.345072W. See figures 2 & 3 for details. 2) Adjustment of sounding, chart indicates 3.4m; least depth of 1.32m observed. Coordinates 53.075320N 4.347508W. See figure 3 & 4 for details.  Data acquired by R.V. Keary: - equipped with Kongsberg EM2040 and POSmv Wavemaster. All depths are reduced to VORF LAT using GPStide methods. Navigation data is reprocessed using PP-RTX and transformed to ETRS89. Data acquired in September 2020, as part of CHERISH program.					
Name of observer/reporter	David Hardy				
H.102A Submitted No	H.102B Submitted No				
Tick box if not willing to be named as source of this information <input type="checkbox"/>					



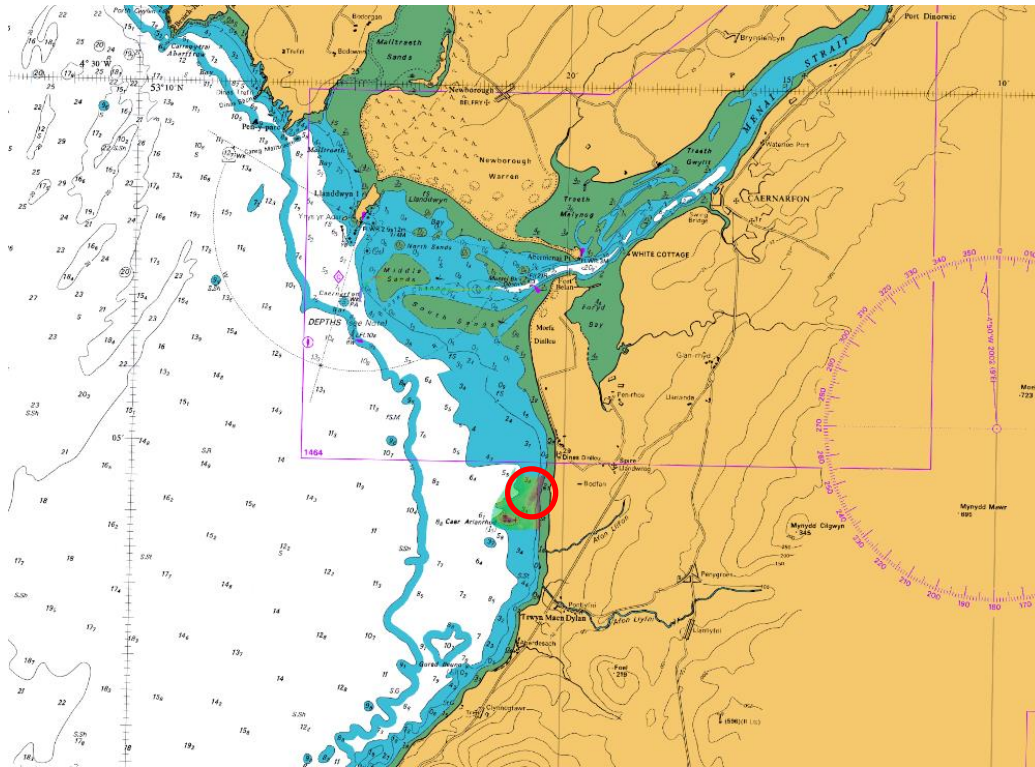


Figure 1 Overview location of survey block, with red circle indicating the area this observation refers to.

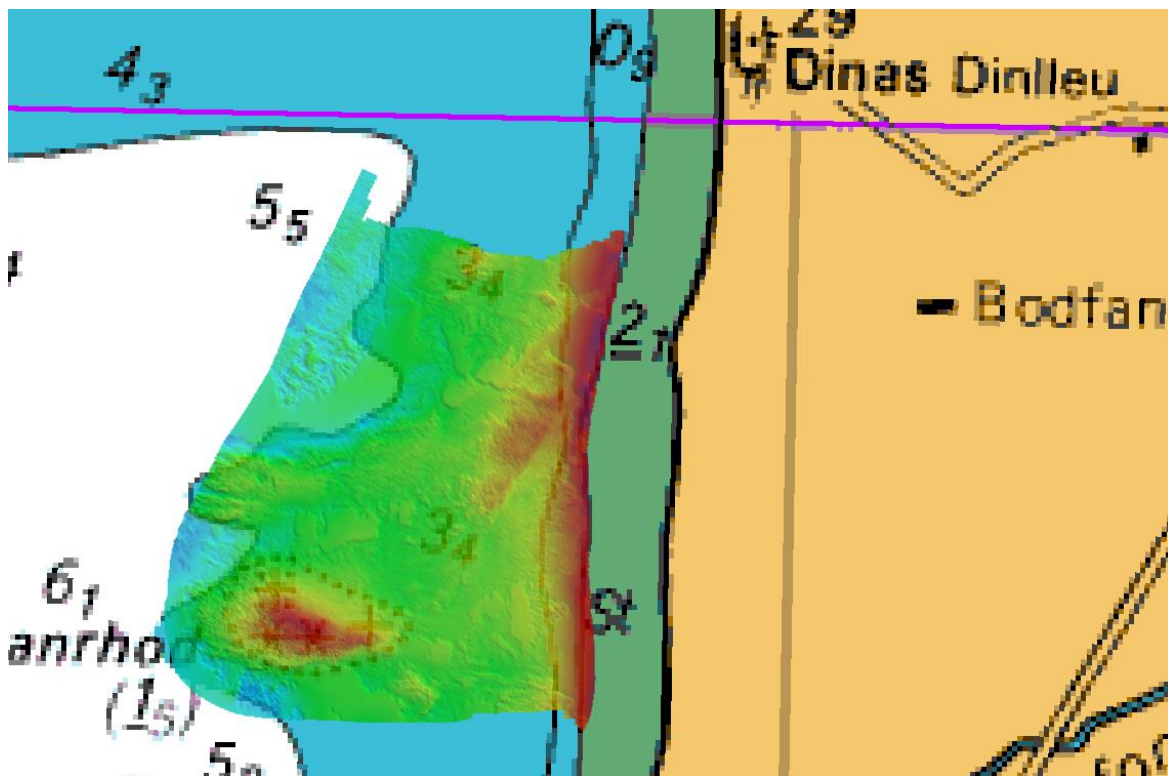


Figure 2 Zoomed images of area being reported.



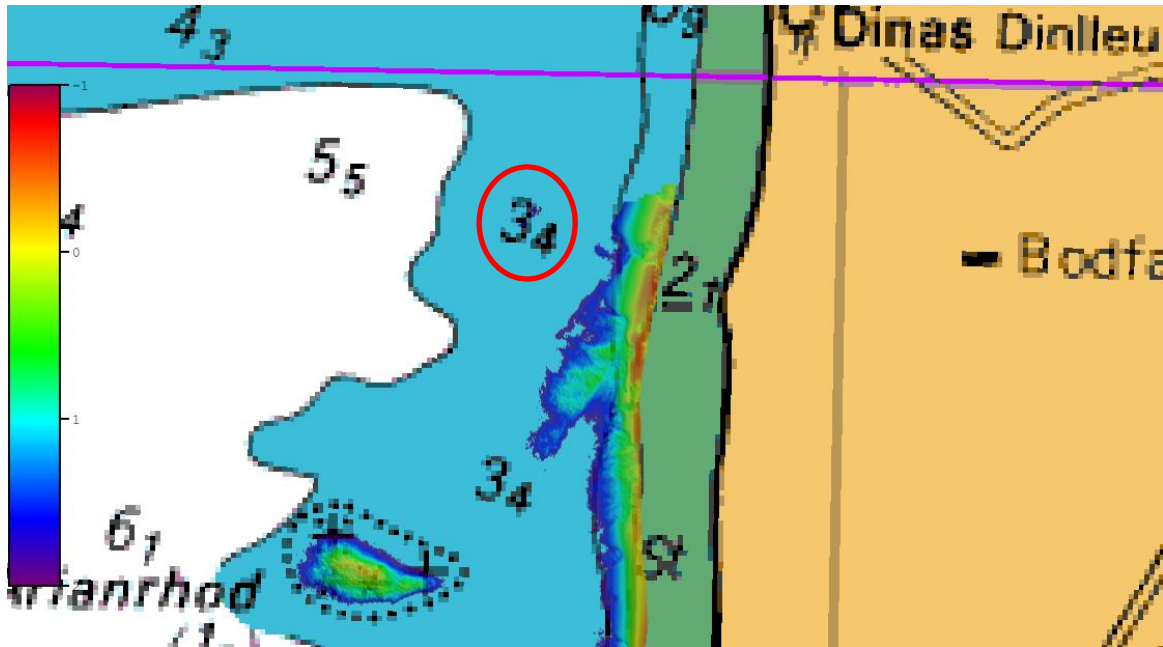


Figure 3 Data filtered to show depths less than 2m LAT, to highlight adjustments needed to contours. Red circle – highlights area less than 2m, obscured by sounding at 3.4m

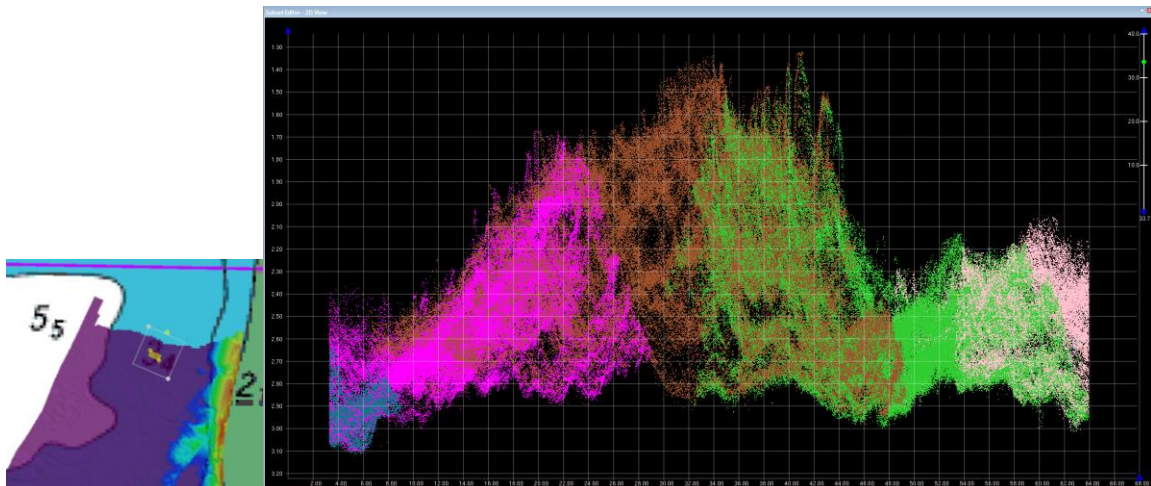


Figure 4 Subset view of data where chart indicates 3.4m, showing shallowest reading of 1.32m.

# HYDROGRAPHIC NOTE

**H.102**  
(V8.0 Oct 2014)

Date	28/06/2021	Ref. Number	KRY20_03— 002DH		
Name of ship or sender	Geological Survey Ireland / R.V. Keary / CHERISH				
IMO number if applicable	-				
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland				
E-mail/Tel/Fax of sender	david.hardy@gsi.ie				
General Locality	Sarn Badrig, west of Barmouth, Wales.				
Subject	Areas of significant depth adjustment, chart 1971				
Position (see <i>Instruction 2</i> )	Latitude	See below		Longitude	See below
	GPS	POSpac -PPRTX	Datum	WGS 84	Accuracy 0.1m
Admiralty Charts affected	1971 (UKHO Geotiff provided 2019)			Edition	Unknown
Latest Weekly Edition of Notice to Mariners held					
Replacement copy of Chart No (see <i>Instruction 3</i> )	<b>IS NOT</b> required				
ENCs affected	<b>NA</b>				
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:  Adjustments to 5m contour in two locations, centred at: a) 52.697665N 4.362514W - Area 1 b) 52.718128N 4.311421W - Area 2  Data acquired by R.V. Keary: - equipped with Kongsberg EM2040 and POSmv Wavemaster. All depths are reduced to VORF LAT using GPStide methods. Navigation data is reprocessed using PP-RTX and transformed to ETRS89. Data acquired in September 2020, as part of CHERISH program.					
Name of observer/reporter			David Hardy		
H.102A Submitted No			H.102B Submitted No		
Tick box if not willing to be named as source of this information <input type="checkbox"/>					



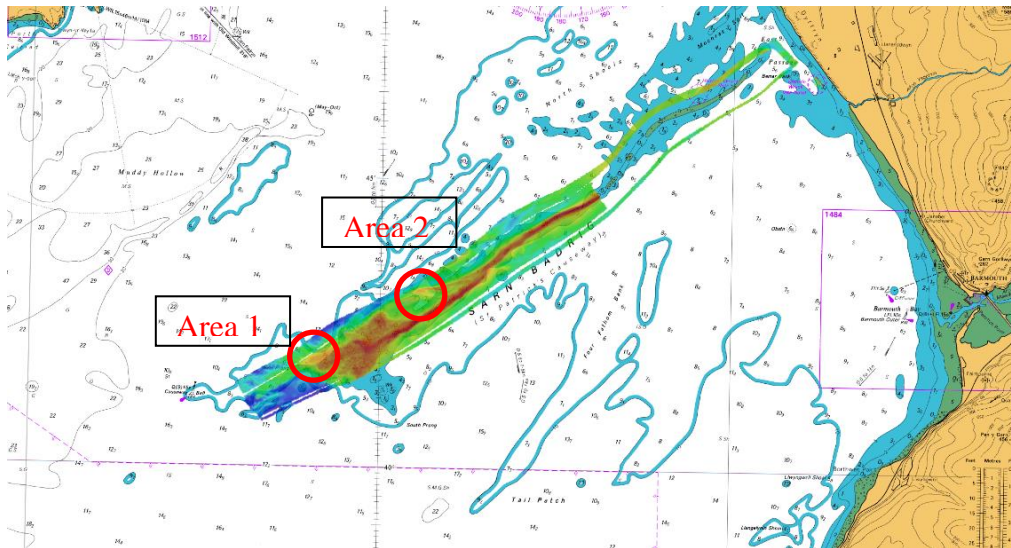


Figure 1 Overview location of survey block, with red circles indicating the areas this observation refers to.

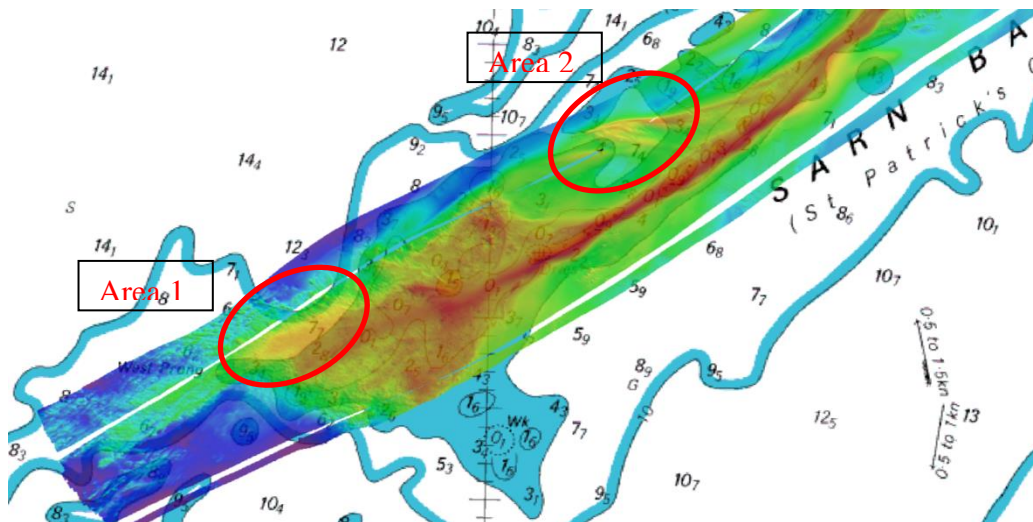


Figure 2 Zoomed images of areas being reported.

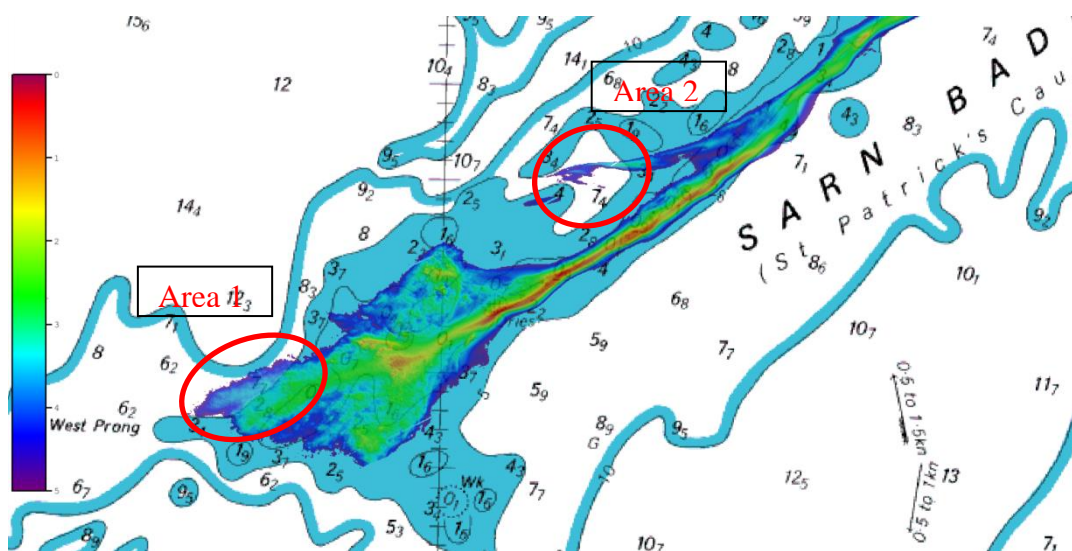


Figure 3 Data display filtered to show depths less than 5m LAT, to highlight adjustments needed to contours.



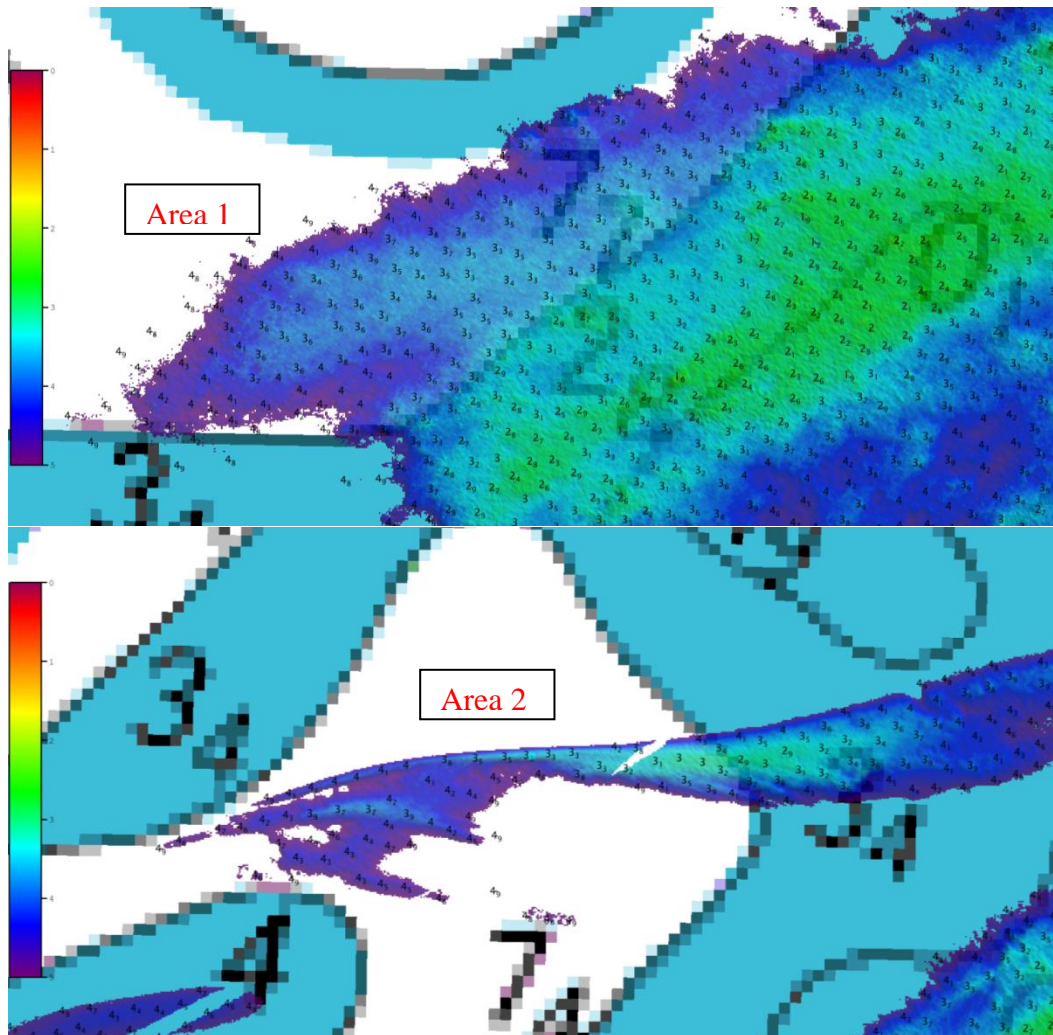


Figure 4 Sounding plots (default HIPS method, 30m radius) over areas 1 & 2 to give indicative depths.



## REPORT OF WRECK INVESTIGATION

Wreck No: 01

Ship/Unit RV Keary

HMOI No:

Survey: KRY20\_03

Date located: 04/09/2020

Date Examined/Swept: 10/09/2020

Listed Position: UNCHARTED

Fixed Position: 52 ° 46 ' 4934' N 4 ° 11 ' 3137' W

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

Horizontal Datum: ETRS89

Depth Data: Swept Clear: N/A metres No sweep, data from EM2040P  
 (VORF LAT) Swept Foul: N/A metres MBES System  
 Least E/S Depth: 6m metres  
 General Depth: 7 m metres  
 Scour Depth: N/A metres

Tidal observations at: Tidal correction derived from GNSS height  
 Cotidal adjustments by:

Contact Data: Sonar Height: 1 metres  
 Sonar Length: 41 metres  
 Sonar Width: 15 metres  
 Orientation: WNW<sup>0</sup> / ESE<sup>0</sup> (Bows: 294<sup>0</sup> )

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

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

Scour Length: N/A Direction (towards): 0

Seabed Texture: Sub-littoral mixed sediments

Debris Field: Yes Length: 10m metres Direction (towards): 43<sup>0</sup>  
 15m 335<sup>0</sup>  
 12m 113<sup>0</sup>

Buoyage: N/A

Description (include attitude and whether intact): The main structure of the wreck appears to be well collapsed/buried, the bow is most likely oriented pointing WNW, with the highest point of the wreck being at the stern section approx. 1m from the seabed. There appears to be debris on the east side of the wreck site approx. 10-15m from the 'centre line'. Reports of wreck 'Diamond' sunk in general area.



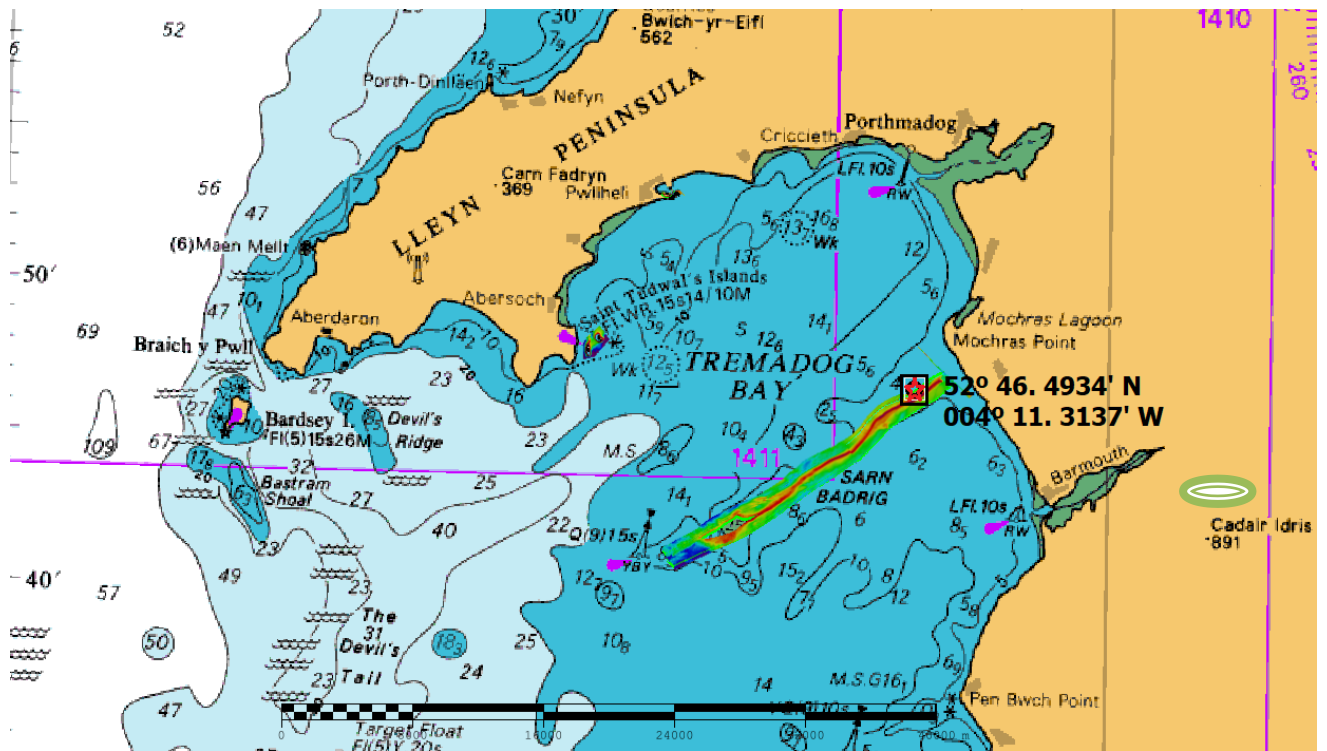


Figure 1: Position of Wreck on Chart



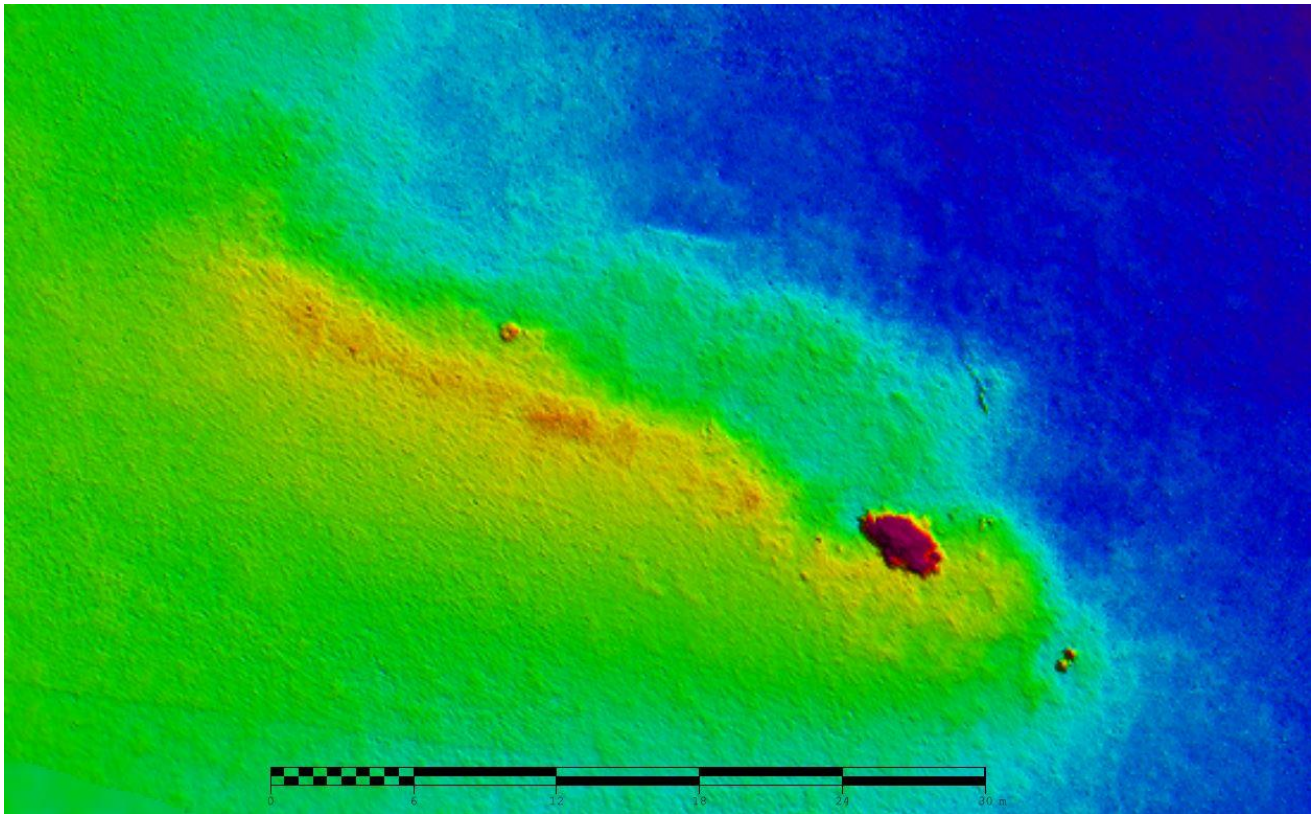


Figure 2: Wreck Orientation on the Seabed.

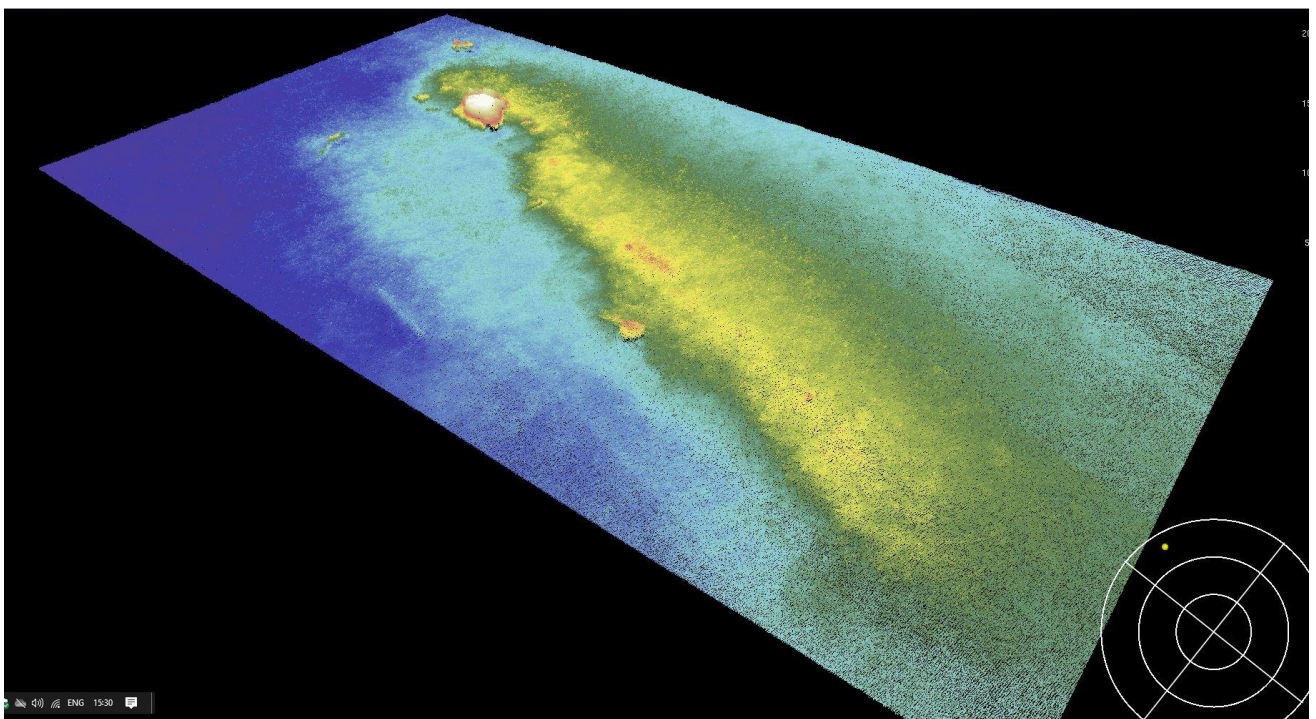


Figure 3: 3D Image of Wreck



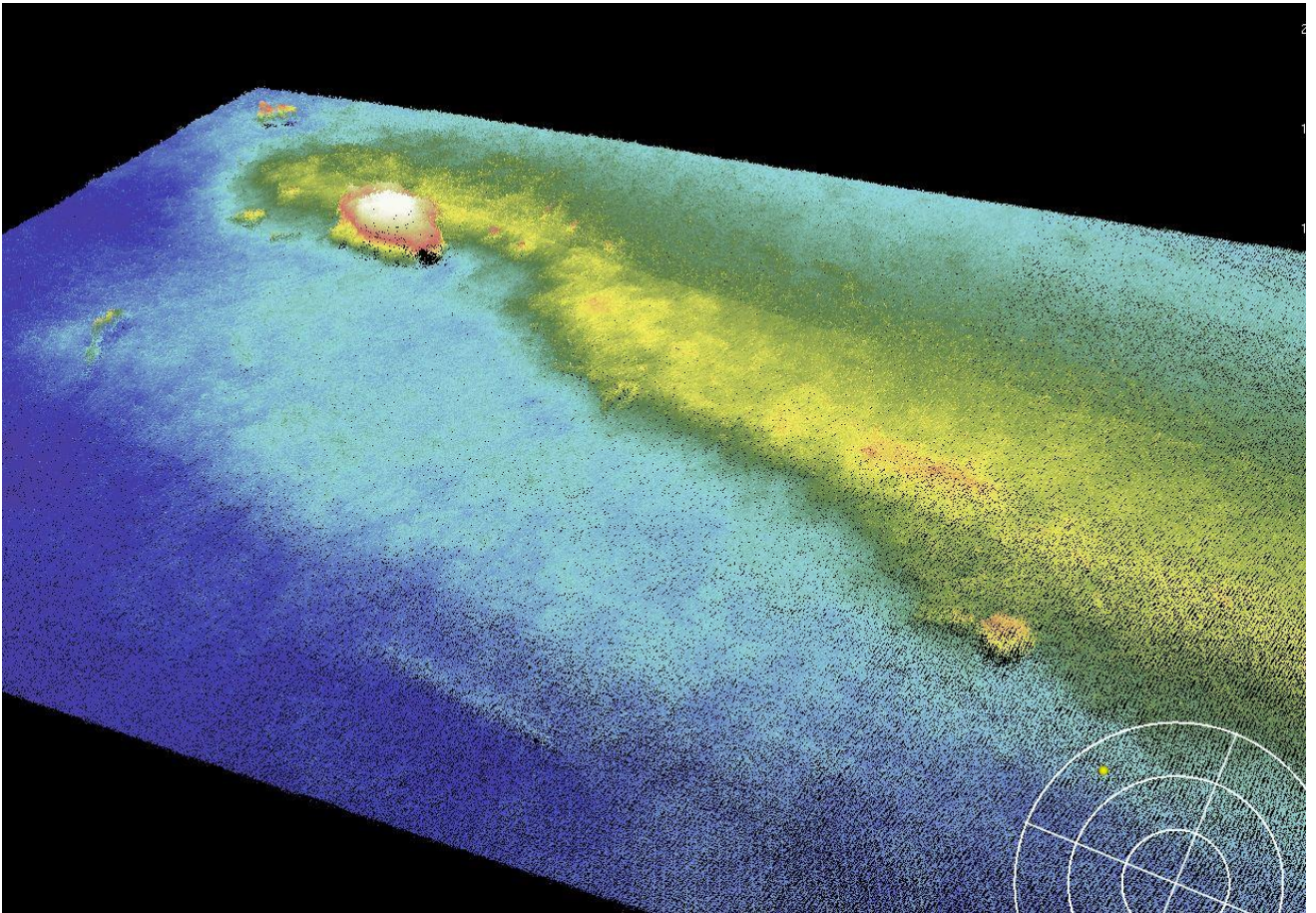


Figure 4: 3D Image of Wreck

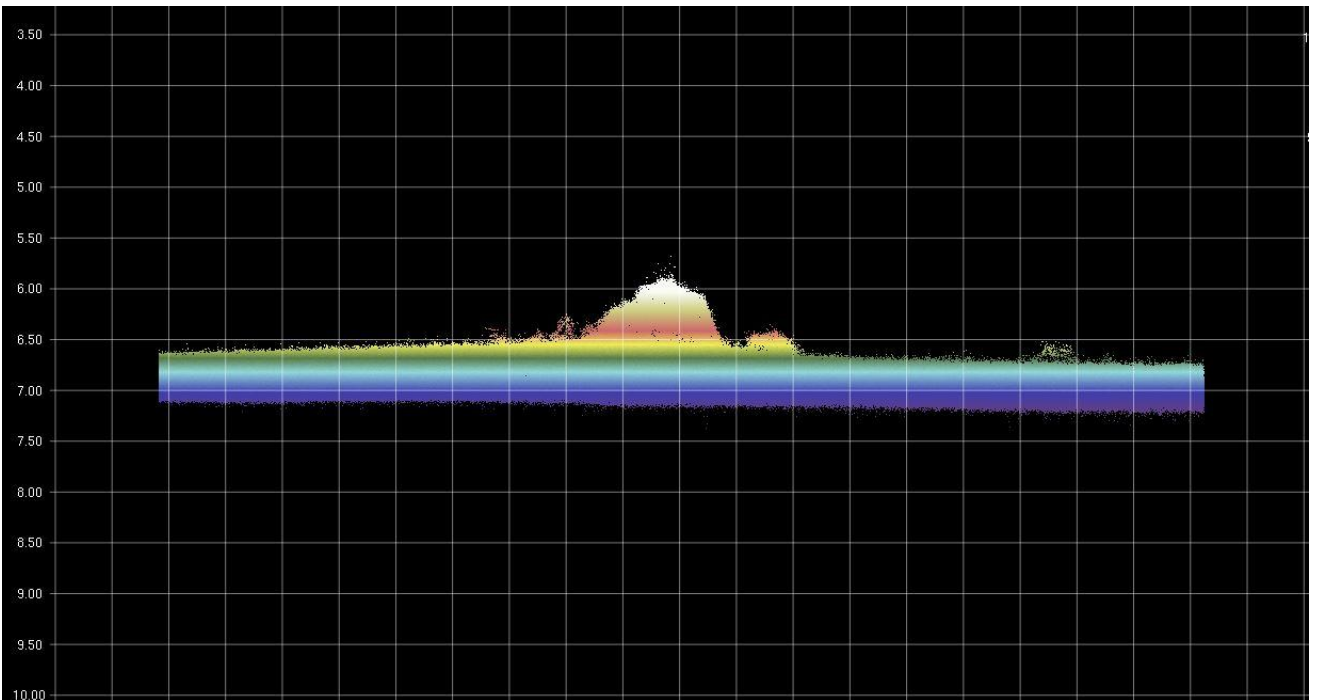
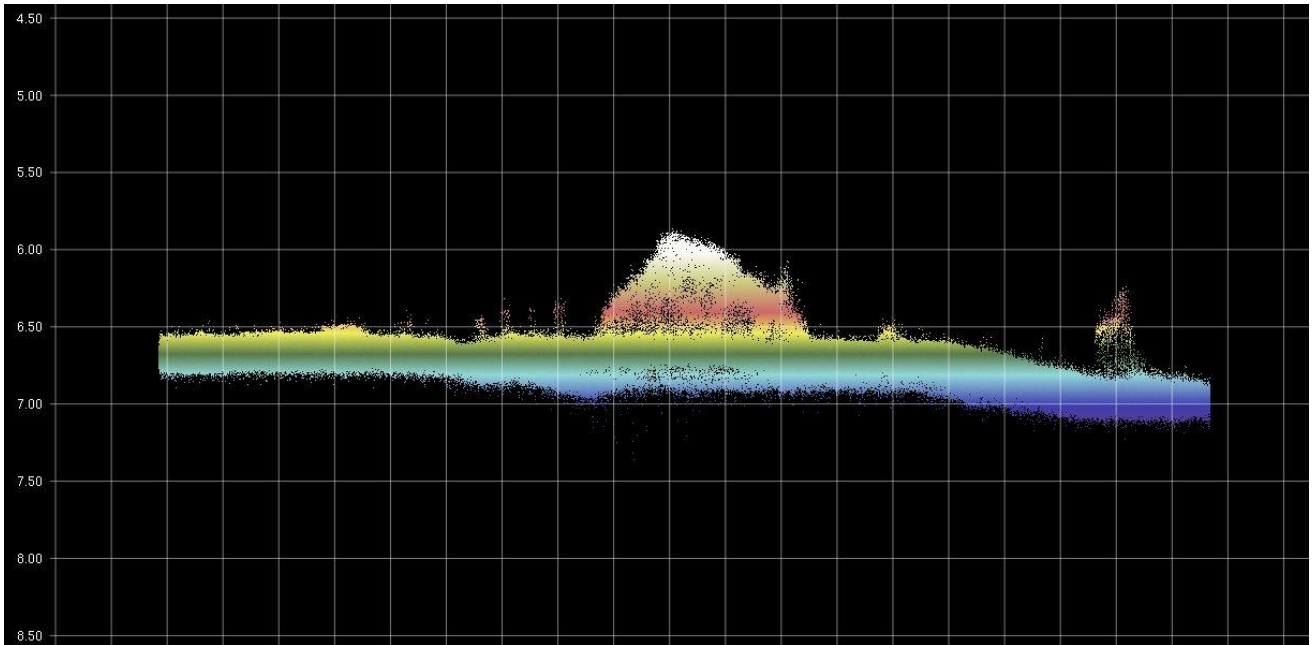


Figure 5: Cross Section along Length of Wreck





**Figure 6: Cross Section Across width**



## REPORT OF WRECK INVESTIGATION

Wreck No: 02

Ship/Unit RV Keary

HMOI No:

Survey: KRY20\_03

Date located: 23/07/2021

Date Examined/Swept: 12/09/2020

Listed Position: UNCHARTED

Fixed Position: 52 ° 42 . 57323 N 4 ° 18 . 7333 W  
1

Method of Positioning: MBES GPS

Accuracy (2,447σ): 0.1 metres

Horizontal Datum: ETRS89

Depth Data: Swept Clear: N/A metres No sweep, data from EM2040P  
(VORF LAT) Swept Foul: N/A metres MBES System  
Least E/S Depth: 0.2m metres  
(?)  
General Depth: 1 m metres  
Scour Depth: N/A metres

Tidal observations at: Tidal correction derived from GNSS height  
Cotidal adjustments by:

Contact Data: Sonar Height: 1 metres  
Sonar Length: 80 metres  
Sonar Width: 20 metres  
Orientation: NE° / SW° (Bows: *Unkn* )  
*own*

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

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

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

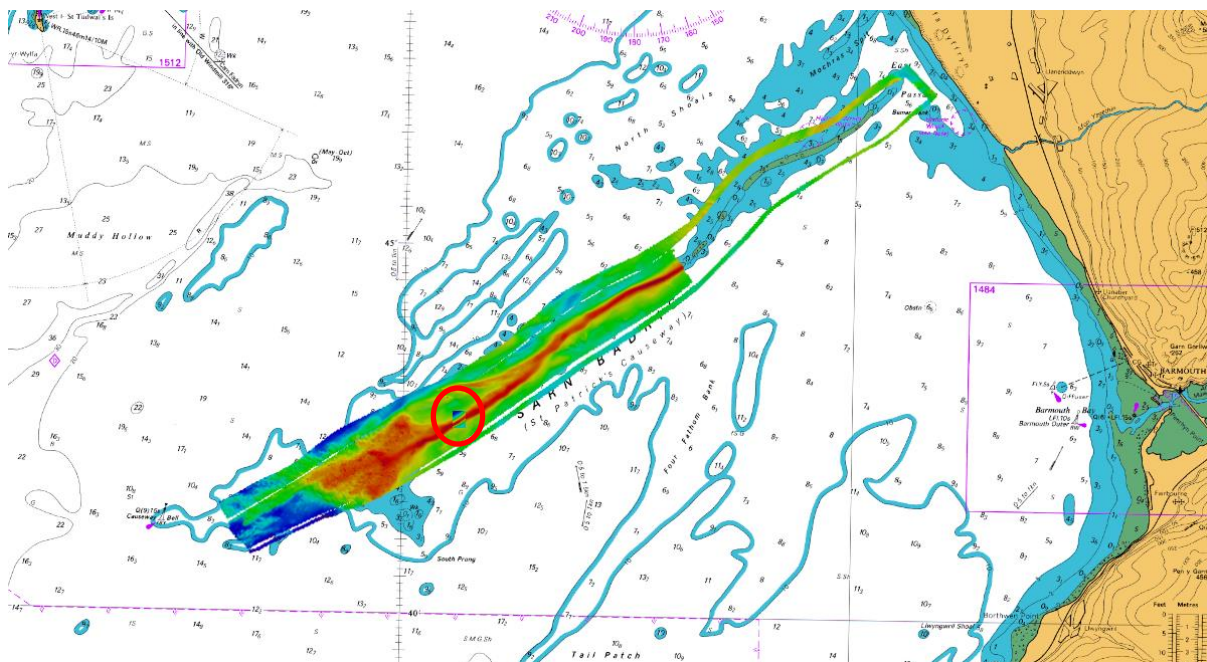
Seabed Texture: Shallow sandbank

Debris Field: Yes Length: 250 metres Direction (towards): N  
93m NE  
78m SSE

Buoyage: N/A



**Description (include attitude and whether intact):** Low relief and fragmented wreck on the crest of Sarn Badrig sandbank. Structure of vessel is collapsed, with a high density of fragments in the local area. Larger fragments in a radius of 80-90m to NE and SSE. To North, at radius up to 250m, 3-4 linear features of approx. 13-14m are observed (potential masts?). Least depth reported is from debris on crest of bank (0.2m LAT). Object is covered by main survey lines only (no wreck investigation) – as was recognised during processing only. Data has a high noise component, due to very shallow environment.



**Figure 7: Position of Wreck on Chart**

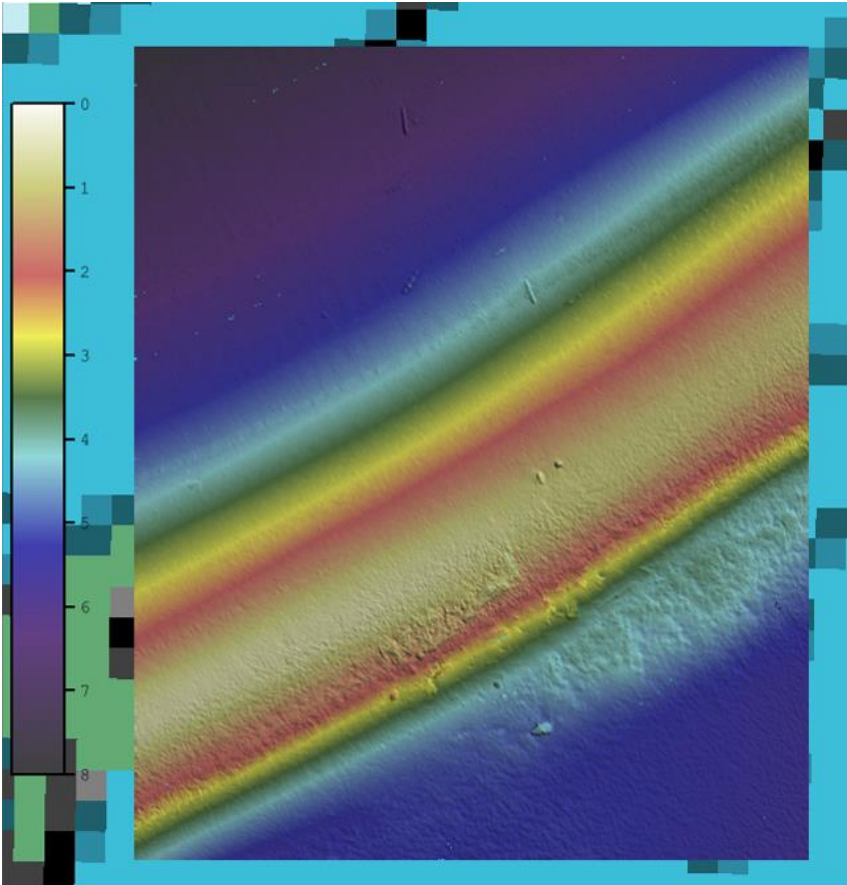
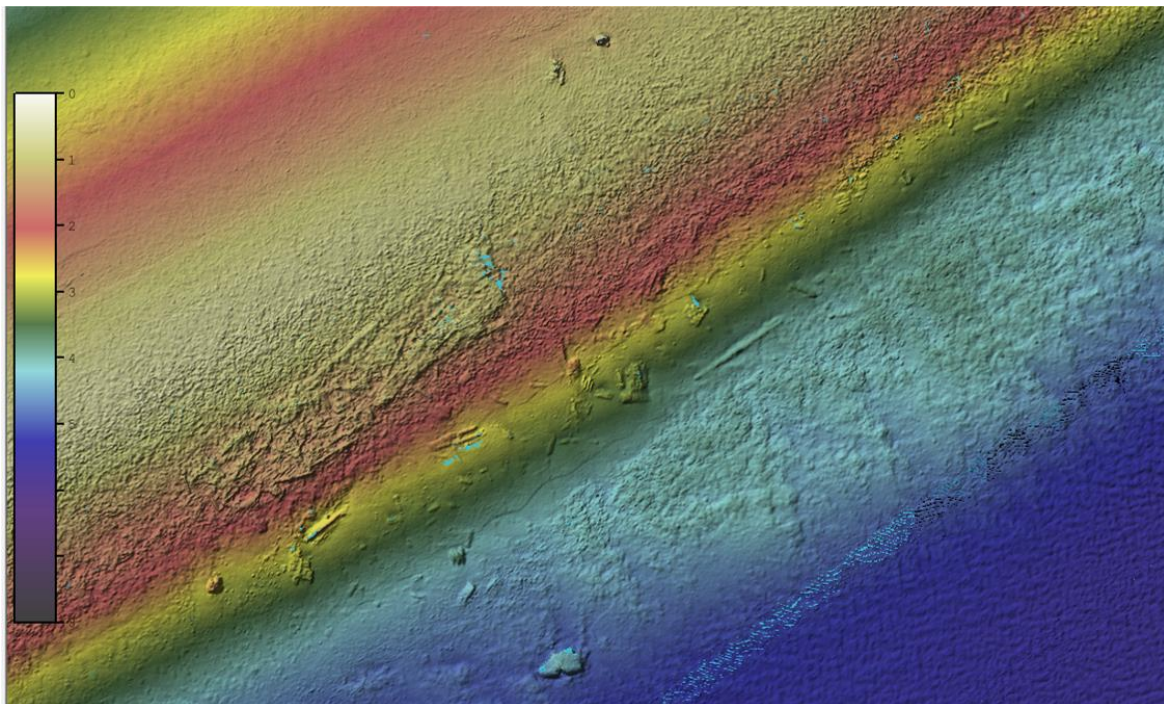
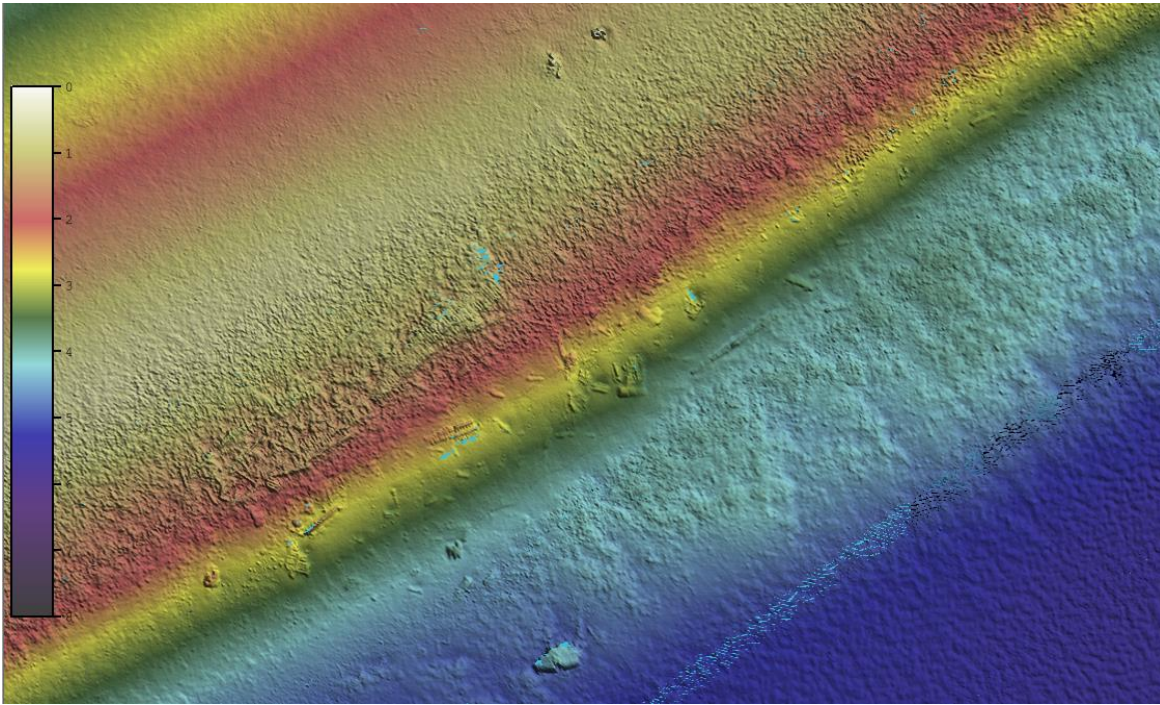


Figure 8: Wreck Orientation on the Seabed.

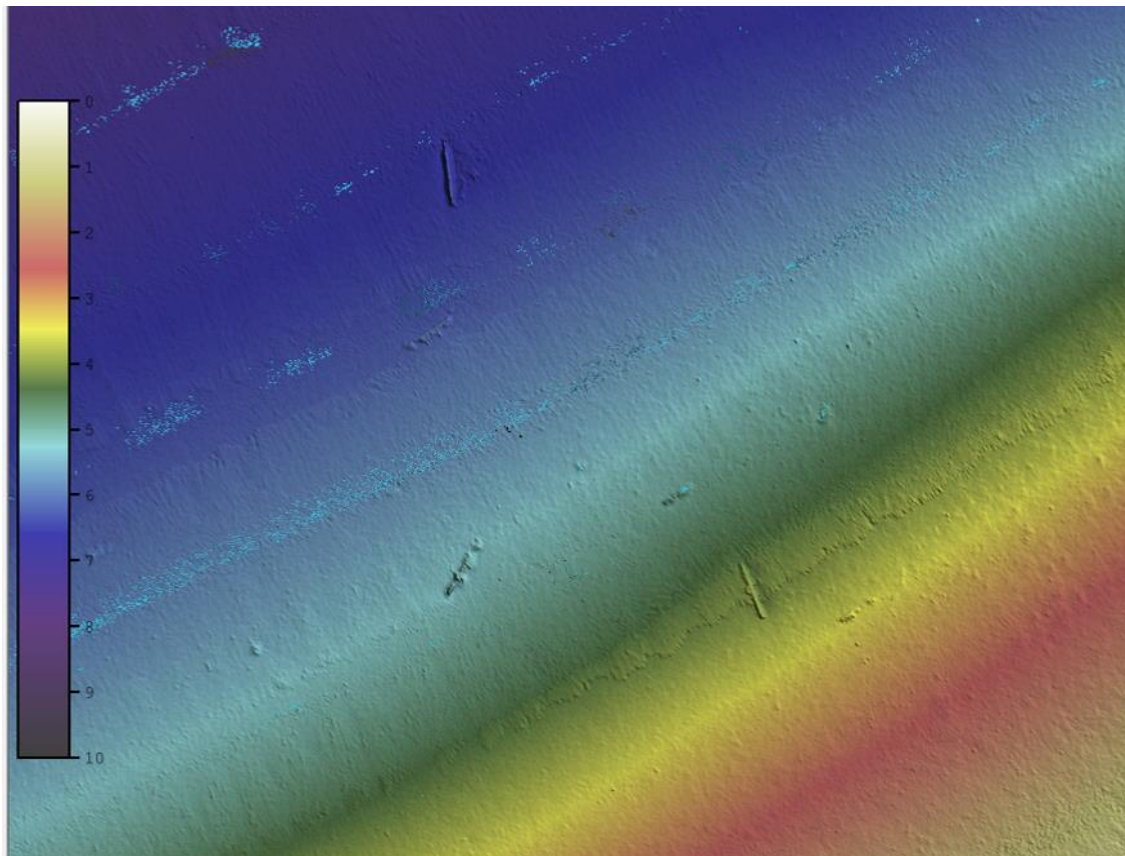




**Figure 9: Wreck main structure & NE and SSE debris fields. Illuminated from NW.**

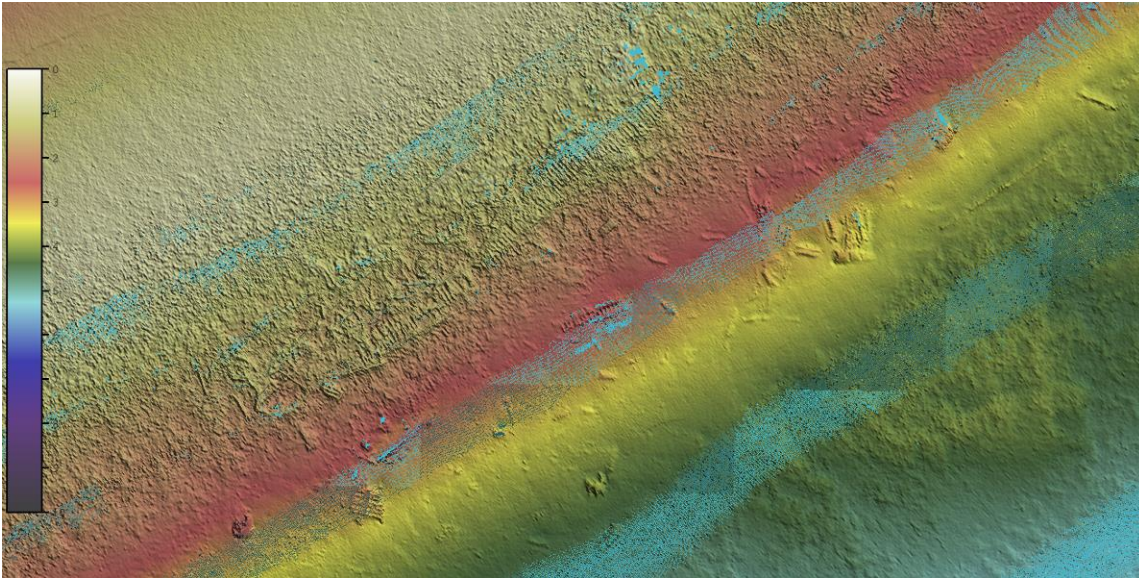


**Figure 10: Wreck main structure & NE and SSE debris fields. Illuminated from NE.**



**Figure 11: Debris field to N of main site (max distance 250m) – showing potential masts?**





**Figure 6: Maximum detail on main wreck site (10cm grid).**

Approved: David Hardy

Data Processor:  
David Hardy

Date: 23/07/2021



## REPORT OF WRECK INVESTIGATION

Wreck No: 03

Ship/Unit RV Keary

HMOI No:

Survey: KRY20\_03

Date located: 23/07/2021

Date Examined/Swept: 12/09/2020

Listed Position: Charted – approx. 150m NE

Fixed Position: 52 ° 42 ' . 28636 N 4 ° 19 ' . 6498 W  
5

Method of Positioning: MBES GPS

Accuracy (2,447σ): 0.1 metres

Horizontal Datum: ETRS89

Depth Data: Swept Clear: N/A metres No sweep, data from EM2040P  
(VORF LAT) Swept Foul: N/A metres MBES System  
Least E/S Depth: -0.6m metres  
(? – drying height)  
General Depth: 2 m metres  
Scour Depth: N/A metres

Tidal observations at: Tidal correction derived from GNSS height

Cotidal adjustments by:

Contact Data: Sonar Height: 2.8 metres  
Sonar Length: 52 metres  
Sonar Width: 13 metres  
Orientation:  $NNE^{\circ}$  /  $SSW^{\circ}$  (Bows: *Unkn* )  
*own*

Sonar Signal Strength: Nil Poor **Moderate** Strong UnknownMagnetic Anomaly: Nil Poor Moderate Strong **Unknown**Scour Length: N/A Direction (towards):  $^{\circ}$ 

Seabed Texture: Shallow sandbank

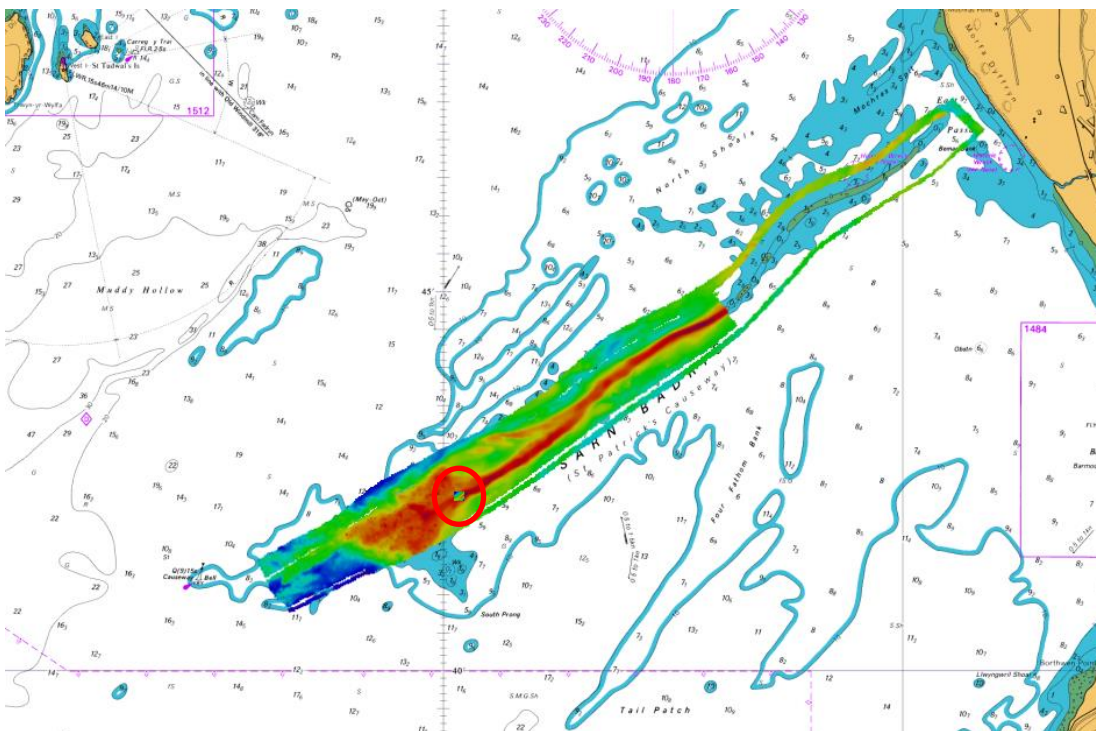
Debris Field: No Length: metres Direction (towards):

Buoyage: N/A



**Description (include attitude and whether intact):** Fragments of charted wreck observed. Data indicates that portions of the wreck will be visible on low tides – least depth of 0.6m above LAT.

Object is covered by main survey lines only (no wreck investigation) – as was recognised during processing only. Data has a high noise component and sonar shadowing, due to very shallow environment.



**Figure 12: Position of Wreck on Chart**

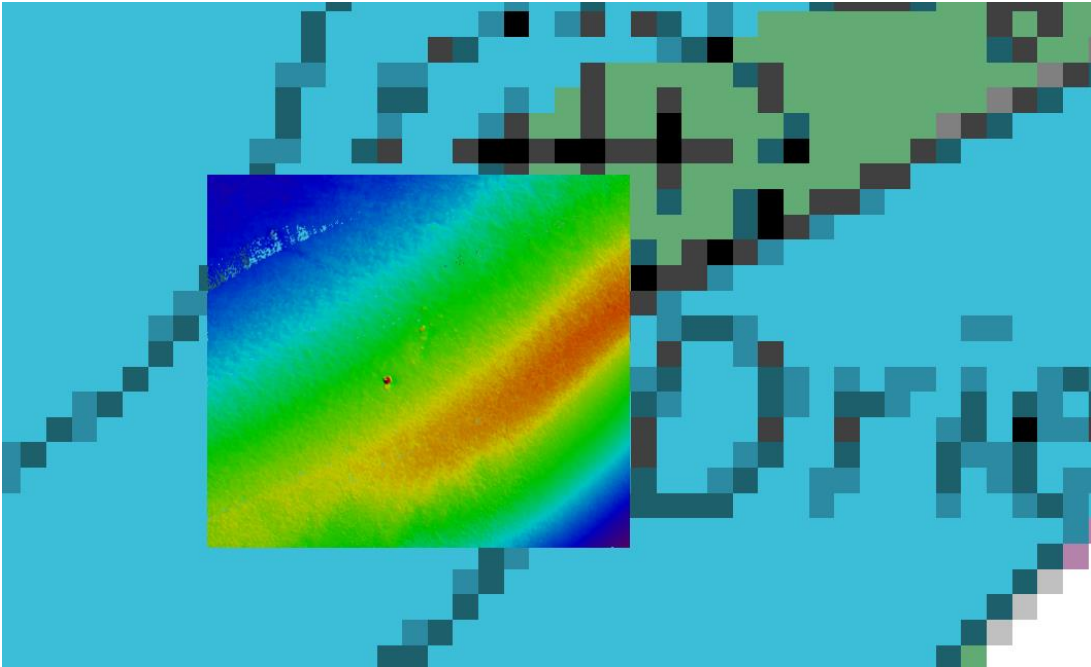


Figure 13: Wreck Orientation on the Seabed.

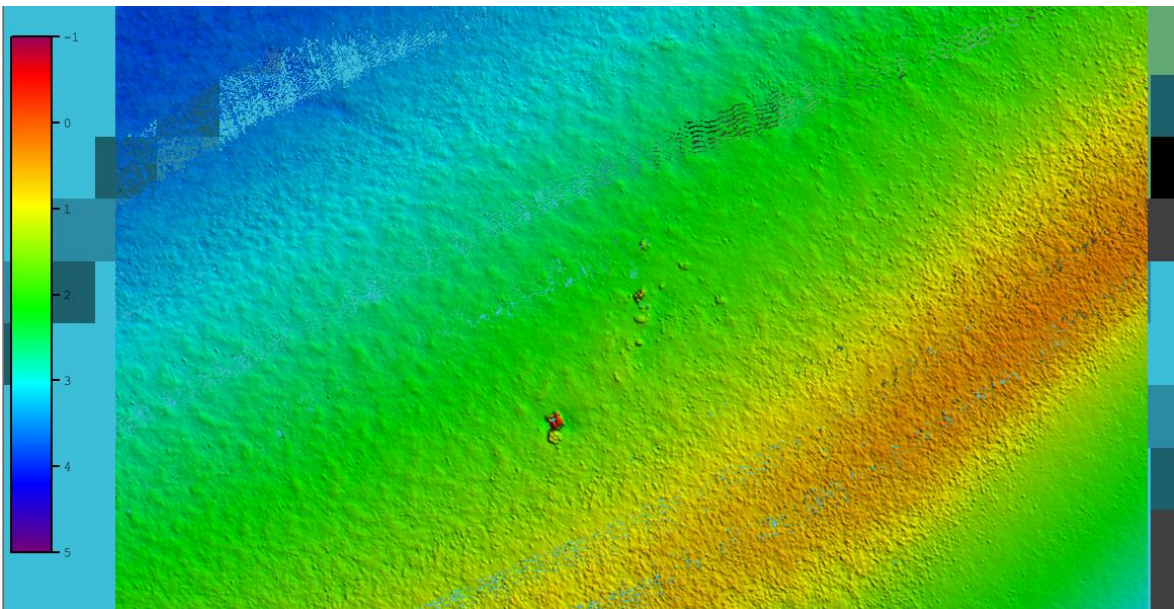


Figure 14: Wreck, maximum details (20cm grid, coverage gaps due to sonar shadowing).





Figure 15: 3D view of wreck.

Approved: David Hardy

Data Processor:  
David Hardy

Date: 23/07/2021

